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CONTRIBUTIONS TO THE STUDY OF PRECOCITY IN CHILDREN

THE HISTORY OF NEUROLOGY

LEONARD GEORGE GUTHRIE
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THE HISTORY OF NEUROLOGY

THE FITZPATRICK LECTURES ON THE
HISTORY OF MEDICINE, DELIVERED AT
THE ROYAL COLLEGE OF PHYSICIANS
IN THE YEARS 1907, 1908

BY THE LATE
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FOREWORD

The lectures that follow are printed exactly as they were left by my uncle at the time of his death. Although he had at one time intended that they should be published, he was never able to devote the necessary time to preparing them for the Press, and they consequently remain rather in the form of notes for his own guidance as a lecturer than as a finished work for the use of others; this will be obvious at once from the want of arrangement of the paragraphs, and from the many insufficient references, with which he would never have been satisfied. It is thought at the same time that his friends may be glad of this small memorial of him, even in its unfinished state, and will understand that its imperfections should be laid not to his charge but to that of the accident which brought his many-sided work to so sudden a close.

I have to thank one of these friends, Dr. Arnold Chaplin, for valuable help; it is to his efforts in the first instance that the present publication is due.

E. G. M.

20 *March*, 1921.

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THE term Precocity is used in somewhat different senses, but in general it implies unduly rapid development, mental or physical, in comparison with some assumed normal standard.

But such a standard is extremely difficult to fix.

We may, for instance, set up our own race as a standard, and say that Negro children are precocious as compared with Whites. But it is open to the Negro to reply—as Terman says—that his standard is the normal, and that our children fall below it.

Again, we may compare individuals of the same race, and construct a standard on a mathematical basis.

For instance, if more boys reach puberty at fifteen than at any other age, it may be assumed that fifteen is the normal age of puberty, and that those who attain it earlier are precocious, whilst those who attain it later than at fifteen are retarded in development.

But such a standard is purely arbitrary. Individuals vary so much that it is impossible to say that any particular one is abnormal in this respect.

Again, we speak of precocious musicians and artists, but there is no such thing as a standard of artistic excellence for comparison.

Musical and artistic prodigies are a law unto themselves.

Yet, although an exact standard for comparison is

Utopian and ideal, there is a vague consensus of opinion as to what constitutes the average mental and physical equipment of the individual, and this is the only test we can apply.

Mental precocity is a variation from a rough and indeterminate average. At one end of the scale are genius and brilliant intellect, at the other amentia or imbecility. The opposite poles are linked together by innumerable gradations. The borderlands between genius, ability and mediocrity, and between dulness and imbecility have no distinctive boundaries.

The average or norm of intellectual standards varies in different ages, races and environments. Standards of eminence are no less difficult to define than standards of mediocrity.

The little Troglodyte who first sketched mammoths on the walls of his cave was precocious in his day. Perhaps his fellow Troglodytes made a god of him; perhaps they bludgeoned him to death with all the savagery of a Quarterly Reviewer. He was born out of season.

In the presence of so-called precocity, dull families and torpid nations cluck like hens in consternation on the brink when their broods of ducklings take to water.

The precocious ugly duckling in the family may be misunderstood, thwarted and goaded into desperation. When he grows up he may be despised and stoned by the crowd, and yet worshipped after death.

On the other hand the world will often bow before the charlatan and think him great. Charlatans are not confined to medicine; they have always existed in art, music, literature and politics. Moreover we all have our heroes; our estimate of an individual's eminence is largely personal.

Standards of eminence in art, science, philosophy, politics and war both rise and fall in nations and in races. For instance, the age which bred Phidias would think but little of that which produced the sculptor of Cobden's statue in the Hampstead Road.

How would the architects of Lincoln and York Minsters look upon those who built our ugly Georgian churches? or how would Rembrandt, Velasquez, Michael Angelo or Chippendale and Sheraton regard the standard of early Victorian artists and upholsterers? Would Aristotle and Plato consort with Tupper, or Keats and Shelley with Eliza Cook on equal ground? A wide gulf separates Balfe from Bach and Beethoven. Yet mediocrities have been considered great in their days. Standards of eminence rise and fall in different ages. When standards are high, pre-eminence is rarely undetected, when low it is often true that the world knows nothing of its greatest men, and mediocrity may pass for genius.

For these reasons I have made no list of those who to myself have appeared the world's great men, but shall draw at random for purposes of illustration on those who have been reckoned so by others.

As I have mentioned, the term precocity is used in different senses.

By some it is regarded as an unduly rapid development, by others as an earlier than average attainment of the ultimate growth of maturity. (Havelock Ellis.)

In either sense it has for the majority an evil significance, and the chief object of these lectures is to discuss how far such views are borne out by facts.

I may state at once that I do not regard intellectual precocity or unusually early manifestations of ability as necessarily morbid in nature.

Nor do I think that precocity implies of necessity prematurity, and therefore speedy decay of intellectual powers.

Yet it seems possible that both views may be correct in certain cases, that precocity may be normal and healthful in one individual, and abnormal and morbid in another and also that there are cases in which precocity both mental and physical may be synonymous with Progeria or premature senile decay.

However, such views are purely theoretical.

Normal intellectual precocity may be defined as an early manifestation of mental development approaching the highest adult type—namely, that of genius.

What has been called morbid or forced precocity is regarded by some as a spurious imitation of unusual mental ability, the result of educational over-pressure and of an environment unsuited to the child's requirements. My own view of such cases is that their intellectual endowment is real, but for the reasons given and others which will be discussed later, it is barren. It is the form of precocity which has gained for early brilliance its evil reputation. I shall again allude to it under this heading, " Psychasthenic Precocity."

Again there is a form of precocity which is purely one-sided, in which one particular faculty is exalted at the expense of all others.

The *Idiots Savants*, to whom further reference will be made, are of this type, but there are less extreme cases in which brilliance in one direction is tarnished by dulness in other faculties, or in which a general want of mental balance, equilibrium and judgment, or a complete absence of emotional control renders talent fruitless.

Individuals of this type may be pathological in the sense that they develop functional neuroses of every kind, but they do not suffer solely in consequence of general or specially determined precocity.

Genius and high intellectual powers, I believe, imply precocity, so it is necessary to decide what genius is.

JOHNSON defined genius as " a mind of large general powers accidentally determined in some particular direction."

But genius does not necessarily specialize. Its highest form is that of *Intellectus Universalis*, which embraces every speciality except perhaps the musical and artistic faculties.

Voltaire held that it is only a very slight line of separation that divides a man of genius from one of ordinary capacity.

Sir Joshua Reynolds thought that all men might become sculptors and painters; and Beccaria was of opinion that any man might be a poet or an orator if he tried. One may concede the orator, but not the poet.

Locke, Diderot and Helvetius believed that all men have an equal aptitude for genius, and Napoleon said that every private carried a marshal's baton in his haversack. Some maintain that genius is only a capacity for taking pains.

Yet it must be admitted that more than mere industry is required to make a Shakespeare, a Darwin, a Wagner, a Michael Angelo, or a Napoleon, although industry, perseverance, self-reliance and enthusiasm are essential to success.

I believe that every genius has shown precocity in one shape or another, although in many cases such precocity has been thwarted, unrecognized or misunderstood.

Intellectus Universalis

The most striking form of precocity is shown in general all-round ability and versatility.

It is commonly said of a really eminent man that he could distinguish himself in any line he chose. That he should specialize in one direction is a mere accident dependent on his taste and inclination.

Goethe's was perhaps the finest instance of the *Intellectus Universalis*. At nine he understood German, French, Latin and Greek, and had learned Italian incidentally by hearing his sister take lessons in the language whilst he himself was engaged in his own studies. All who taught him claimed him as their own—one as a predestined man of science, another as a born artist, a third as an erudite theologian, a fourth as an accomplished courtier, a fifth as a diplomatist, a sixth as a *juris consult.*

It is probable that Goethe would have been regarded as a genius in any special branch—whether poetry, art, science, law, or philosophy—had he chosen to devote himself exclusively to it.

" But he was essentially a man of thought rather than action, and although largely engaged in the practical business of his adopted country his heart was always in speculation on artistic production.

" Whilst inspecting mines he was spinning theories of geological formation ; in the defiles of Argonne and in the trenches before Mainz he was scheming and arranging his theory of colours ; a bombardment was valued less by him as an attack upon the enemy than as a series of interesting experiments in Optics."—(*British Encyclopædia, p.* 735.)

I will take as a good instance of the *Intellectus Universalis* the case of Dr. Thomas Young.

Dr. Thomas Young[1] was born at Milverton, in Somersetshire, 13th June, 1773.

At the age of *two* he could read fluently.

Before he was *four* he had read the Bible through twice.

At the age of *six* he learnt by heart in six weeks Goldsmith's *Deserted Village.*

Went to school when not quite *seven* years, stayed there one and a half years. When nearly *nine* (March, 1782) went to another where he remained four years. Here he read Phædrus's Fables, Cornelius Nepos,

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[1] The following extracts are from *The Mummy*, by Sir E. A. Wallis Budge, Keeper of the Egyptian and Assyrian Antiquities, British Museum. Cambridge, at the University Press, 1893. See also *Life of Thomas Young*, by (Dean) G. Peacock, London, 1855.

Virgil, Horace, the whole of Beza's Greek and Latin Testament, the first seven books of the Iliad, Martin's Natural Philosophy, etc. etc.

Before leaving this school he had got through six chapters of the Hebrew Bible. At this same time he learnt to use the lathe, made a telescope and microscope; and the Italian, Persian, Syriac and Chaldee languages all occupied his attention.

From 1787–92 was tutor to Hudson Gurney at Youngsbury, Herts, where he studied English, French, Italian, Latin, Greek, Hebrew, Chaldee, Syriac, Samaritan, Arabic, Persian, Turkish and Ethiopic, as well as Natural Philosophy, Botany and Entomology.

1792 began to study Medicine at St. Bartholomew's Hospital.

1803 read paper before Royal Society, and was elected Fellow next year. Took his degree, M.B., at Cambridge.

Discovered undulatory theory of light.

1814 discovered some of the values of the Egyptian hieroglyphic characters.

1816 appointed secretary to a commission for ascertaining the length of the seconds pendulum, etc.

1818 Secretary to Board of Longitude and Superintendent of Nautical Almanac.

1829, February, began to suffer from "repeated attacks of Asthma," and died on May 10th of that year.

GROTIUS (1583–1645).—Hugo Grotius could make good Latin verses at nine, was ripe for the University at twelve, and at fifteen edited the encyclopædic work of Marcianus Capella.

"The high reputation which Grotius attained in his lifetime, though it rests in parts, like that of Erasmus, on the diversity of his accomplishments and the comprehensiveness of his literary view, had also a scientific basis in a professional speciality.

"He was a great Jurist, and his book *De Jure Belli* entitles him to the honour of being held the founder of the modern science of the law of Nature and Nations."—(*Brit. Enc.*)

William Wotton (1666–1726).—Could read a psalm when aged four years and six weeks. By five years of age he could read the Gospels in Latin and Greek; five months later he began Hebrew.

At five and a half he began Homer and Virgil, and by six he had read the golden verses of Pythagoras, the first three eclogues of Virgil, and some Terence and Cornelius.

He then for the first time learned the declensions and soon after the rest of grammar.

In 1672, at the age of six, he was examined by Sir Philip Skippon, who certified to his knowledge of Latin, Greek and Hebrew, which he could read almost as well as English, but added in a letter that "what he performs . . . is done by strength of memory."

Sir Thomas Browne also examined him on 20th July, 1672, and certified that he read a stanza in Spenser very distinctly, also some verses of the first eclogue of Virgil, some verses of Homer, and of the *Carmina Aurea*, and the first verse of the fourth chapter of Genesis in Hebrew, and construed all accurately.

He entered Cambridge University when less than ten years of age, and John Eachard, the Master of St. Catherine's Hall, described him as, "Nec Hammondo, nec Grotio secundus."

John Evelyn refers to him (July 6th, 1679), saying: "But what was more admirable than his vast memory was his judgment and invention, he being tried with divers hard questions which required maturity of thought and experience. He was also dexterous in chronology, antiquities and mathematics."

In after life he maintained his early reputation. His book, *Reflections upon Ancient and Modern Learning*, published in 1694, may still be read, as Sir Norman Moore has said, as the best summary of the discoveries on Nature and Physical Science up to its date.

He also published learned treatises on Jewish customs, studied and wrote upon the Celtic tongue, and preached Welsh sermons, besides engaging in theological controversies, and incurring the satire of Swift for having described the *Tale of a Tub* as a "profane piece of ribaldry."

His attitude was perhaps natural, but suggests that in humour at all events he was not precocious.

All his learning did not, however, advance him beyond a Fellowship at Cambridge and a country parsonage.

John Evelyn gives a lengthy account of young CLENCH, a boy of eleven, son of Dr. Clench, afterwards murdered in his coach.

Mr. Pepys and Evelyn examined him together. "There was not anything," Evelyn says, "in chronology, history, geography, the several systems of astronomy, courses of the stars, longitude, latitude, doctrine of the spheres, courses and sources of rivers, creeks, harbours, eminent cities, boundaries and bearings of countries, not only in Europe, but in any other part of the earth which he did not readily resolve and demonstrate his knowledge of. He was not only able to repeat the famous things which are left to us in any of the Greek or Roman histories, monarchies, republics, wars, colonies, exploits by sea and land, but all the sacred stories of the Old and New Testament, the succession of all the monarchies, Babylonian, Persian, Greek, Roman, with all the lower Emperors, Princes, Heresiarchs and Councils—what they were called about, what they determined; or in the controversy about Easter, the tenets of the Gnostics, Sabellians, Arians, Nestorians; the difference between St. Cyprian and Stephen about Rebaptization; the Schisms."

He answered questions on Synchronisms, Olympic years, civil laws and on the Digest and Code, and gave a "stupendous account of both Natural and Moral Philosophy and even in Metaphysics." "He was perfect in arithmetic, Latin authors and French, and was newly entered into Greek."

"He was as beautiful and lovely in countenance as in knowledge," of a lively, sprightly temper, always smiling and exceedingly pleasant, without the least levity, rudeness or childishness.

The examination must have taken a considerable time, and it is as creditable to Evelyn's and Pepys' range of knowledge as it is to the little boy's.

Indeed, one seems to see in this account a trace of the "little conceitedness" which Pepys saw in Evelyn, and shared himself.

All cases of the *Intellectus Universalis* have a strong family likeness, and many instances might be commemorated.

The last to which I shall refer is that of John Stuart Mill (1806–1873).

He was brought up by his father on a system which cannot be commended.

He began Greek at three, and at eight had read many Greek authors, including Æsop, Xenophon, Herodotus, parts of Lucian, Diogenes Laertius, and six dialogues of Plato.

He then began Latin, and by his twelfth year had read much of Virgil, Horace, Livy, Ovid, and Terence and Cicero, Thucydides, and parts of the dramatists, orators and historians. Between eight and thirteen he had acquired elementary geometry and algebra thoroughly and had begun the differential calculus. He was interested in popular books of science, but was not given opportunities of experimental enquiry. He had no taste for poetry.

At twelve he began to study logic. At fourteen he went through a complete course of Political Economy.

At six and a half he had composed some fragmentary histories, and during his eleventh and twelfth years he began to write a history of the Roman Government in imitation of Hooke.

Amongst artists who showed the *Intellectus Universalis* may be mentioned LEONARDO DA VINCI, who was at once artist, sculptor, architect, mathematician and engineer.

Amongst musicians, WAGNER is perhaps the best example of the versatile form of genius.

Early Bent and tendency to Specialize in Precocious Children

It is often lamented that biographies in general give little information concerning the early childhood of their subjects. Beyond a reminiscence or two, usually related in a semi-humorous manner, there is little to give a clue to early tendencies which shape a life's career. Sometimes the anecdote or reminiscence is trivial, sometimes it is of great importance. If the scheme of psychologists for recording life histories of great men from the earliest period of their existence had been followed we should possess most interesting and valuable information; on the other hand we should have to deal with a vast amount of irrelevant and elaborate fiction.

The Bible, although a complete study of man in all his phases, tells us little about children beyond that which is contained in the precepts of Solomon, which have a certain sameness both in theory and in application.

The precocious dreams of Joseph, and Samuel's stern denunciation of his master's weakness, are indications of their future greatness. David to his brethren was only the lad who brought their lunch to them in battle and " in the pride and naughtiness of his heart " wished to stay and to see the fun. Yet his precocity was observed by others and caused him to be chosen out from all the tribes to lead them.

" Provide me now a man that *can* play well," said Saul, perhaps exasperated by the incompetence of the Court Musicians; and David, the precocious harpist, was selected for the post (1 Sam. xvi. 17).

Perhaps the silence which often prevails depends upon the fact that man is but a child grown up. The child is father to the man, but the man is also father to the child and like him in general disposition. We often, for instance, meet a man and think with probable correctness what an uncommonly disagreeable boy he must have been.

Similarly, inferences may be drawn as regards his abilities and other traits.

Details of early life may be interesting but are not always necessary.

Biographers and autobiographers with certain exceptions regard such matters as immaterial compared with the great event of manhood.

By many, childhood itself is regarded as a necessary evil or mere preliminary to be shortened as much as possible by education.

Rousseau opposed this view.

" We pity the state of infancy," he says, " we do not perceive that the race would have perished if it had not begun by being a child."

Certainly in his own case he spared us little of his juvenile impressions and adventures, and other autobiographers of the egoistic kind have followed his example.

Indications of precocity may be understated and overstated: on the whole, making all allowance for bias on the part of the narrators in special cases, the evidence is in favour of the view that the prevalence of precocity in men of genius has been underrated.

Indications of Early Bent related by Plutarch

Plutarch in many of his lives is at pains to show the early tendencies of his heroes.

I can only mention a few instances in which he alludes to accidental circumstances, which determined future careers, or to incidents in childhood which revealed them.

Aratus the Smyrnian, he tells us, acquired at the age of seven a vehement hatred of all tyrants, after narrowly escaping death at the hands of one, and his hatred lasted through his lifetime.

Demosthenes as a boy, after hearing the orator Callisthenes plead before the judges, was so impressed that he left off study of all other sciences, and all other exercises of wit and body in which other children are brought up, and laboured continually to become an orator.

Themistocles at school would never play, nor would he ever be idle as other children were. He was always found conning or composing some oration with intent to defend or to accuse some of his companions.

He could not be taught manners or civility nor anything for pleasure or honest pastime, but only matters of wit and things of weight concerning state affairs.

His masters prophesied that he would do some notable good thing or some extreme mischief to his country.

A few anecdotes which Plutarch tells of Alcibiades in his boyhood give the whole character of that brilliant "enfant terrible"; his wit, his power of impressing others, his unbounded impudence and craving for notoriety.

He declined to learn the flute. "One makes a foolish face in flute playing," he said, "moreover, one cannot play it and talk too. It is only fit for Thebans who cannot talk." So all the little Athenian boys struck at flute playing and the art was banished from the curriculum.

Again we see him playing " scales " in the street with other boys. A carter comes along : " Stop till I've had my throw ! " he cries, but the churlish carter drives on, grinning. The others scatter but Alcibiades throws himself on the ground before the horses bawling : " Drive over me if you dare ! "

He runs away from school and seeks some disreputable haunt. His tutor begs his uncle Pericles to send out the town crier ; but Pericles knew his nephew and his desire for self-advertisement : " If he is murdered," said he, " we shall find out to-morrow, if he is safe the less said about his escapade the better."

Another example illustrating a type of precocity which may be called the " precocity of reticence " is given by Plutarch in the case of Quintius Fabius Maximus.

Quintius Fabius Maximus was called a little sheep at school. He was dull, still and very silent, seldom seen to play, of slow capacity, hard to learn and to conceive. He allowed other boys to bully him and was regarded as a very fool and idiot by some. But others, Plutarch says, saw in him " the secret constancy and majesty of the Lion."

Innumerable instances might be given to show the early stage at which bent towards a future lifework is manifested or the apparently insignificant nature of the event which prompted it.

Other Instances of Accidents Determining Bent

Haydn's genius was first fired by hearing Handel play.

Josiah Wedgwood at eleven was confined to bed by disease of the knee-joint which, as Gladstone said, "drove him to meditate upon the laws and secrets of his art."

CHATTERTON'S passion for medieval MSS. and also for forging them was excited by seeing an illuminated letter on the cover of a sheet of music.

CUVIER'S love for natural history was brought to light by seeing Buffon's coloured plates.

RUSKIN speaks of the effect upon his imagination of pictures in his father's house.

DUMAS and CHARLES LAMB tell of the results upon their imagination produced by pictures in the Bible.

FLAXMAN as an invalid child was led to copy casts of the antique in his father's shop by reading of Ajax and Achilles.

AMBROSE PARÉ took to surgery after seeing an operation for lithotomy when an uneducated boy.

TYCHO BRAHÉ (1546–1601) saw an eclipse of the sun at fourteen, and henceforth devoted himself to the study of astronomy.

ROBERT MURPHY (1806–43), examiner in mathematics and natural philosophy to London University, whilst lying in bed with a fractured femur in his eleventh year, was presented with an old Cork almanac containing mathematical problems. He then asked for Euclid and Algebra and mastered both before he was thirteen.

ASTLEY COOPER discovered his bent for surgery by the kudos which he gained for improvising a tourniquet for a boy who had a compound fracture of the femur. Fortunately he put the tourniquet on the right side of the wound or we might not know of him.

Unrecognized Bent

Some instances of supposed dulness in the early lives of great men may be due to their strongly developed critical faculty which resents the manner in which subjects are presented to them.

Precocious Critical Faculty

Heine regarded Greek as the invention of the devil. "God knows what misery I suffered with it," he said. He hated French metres and his teacher vowed he had no soul for poetry. He was "horribly bored" by the "odious stiff cut and dried tone" of his professors, having views of his own on the matter.

Hegel was a poor scholar, and was stated to be "of middling industry and knowledge and *extremely deficient in philosophy*." One cannot doubt that he brooded over his own obscure system, whilst criticizing unfavourably that of others.

Berlioz left the Paris Conservatoire of Music disgusted at the dry pedantry of his teachers, and struck out a new line for himself.

Rossini's early dislike for music probably was caused by his musical parents who tried to press his inclinations.

Precocity and Originality of Mind are often Unappreciated and may be Baffled by Uncongenial Tasks

Linnæus could not learn languages. Leigh Hunt could not be taught the multiplication table.

Goldsmith's teacher thought him the dullest boy she had ever tried to instruct.

Chatterton's mother regarded him as "little better than an absolute fool" at six and a half.

Humphry Davy at school was an idle boy with a gift for making verses but with no aptitude for studies of a graver sort. Afterwards he considered it fortunate that he was left so much to himself.

Huxley detested writing till past twenty, and complained that his teachers "cared as much for his intellectual and moral welfare as if they were baby farmers."

Byron was always bottom of his class as a schoolboy.

Sheridan was remarkable for nothing else but idleness and winning manners. He was not only slovenly in construing but unusually defective in Greek grammar.

Darwin was considered at school as rather below the common standard in intellect. His father said to him: "You care for nothing but shooting, dogs, and rat-catching, and you will be a disgrace to yourself and all your family."

Honoré de Balzac was considered at eight years of age as the idlest, most callous boy in his division, and was caned and confined in the school dungeons in consequence. The fathers of the seminary knew nothing of his craving for reading: his dreamy mental states were regarded as pure laziness.

In contrast may be mentioned the wise treatment of Descartes by the Jesuit Fathers of La Flèche. Marking that his mind was "naturally disposed to meditation" they allowed him to be late in bed, excused him attendance at lectures, and relieved him of much routine work done in common with other boys (cf. *Lope de Vega Carpio*, p. 50 below).

Similarly, the poet Abraham Cowley (1618–67) could not be forced by his masters to the drudgery of learning grammar, so they excused him on the ground that his natural quickness made it needless. Such leniency in the ancient school of Westminster is only explained by the fact that Cowley escaped by a bare year the discipline of Busby.[1]

Instances might be multiplied in which eminent men, when children, have quietly and steadfastly followed their own line, refusing with dogged obstinacy and perseverance to conform to any stereotyped course of learning.

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[1] Cowley failed to matriculate at Cambridge in 1636, but gained a Scholarship at Trinity next year. Busby succeeded Osbolston, who was deprived of the Headmastership of Westminster in 1638 (*Dict. of Nat. Biography*).

They have often been branded as dunces and dullards, yet in reality have been more precocious than any.

Sometimes a fastidious hesitancy to admit that learning has been mastered may pass for stupidity. JOHN WESLEY'S mother declared that she had to repeat a thing twenty times to her famous son, but after the twentieth time he never forgot.

WELLINGTON ("my dull boy Arthur" as his mother called him) was similarly slow in grasping facts and equally tenacious of them—and the same has been said of the late Duke of Devonshire.

Varieties of Intellectual Precocity

Our minds and faculties are many-sided. Some have five talents, some two or one, and some have none at all.

Talents possessed may be displayed or hidden in a napkin.

Intellectual precocity has to be considered in relation to normal development of brain function which proceeds in the following order (Clouston):

1. Trophic functions are earliest.
2. Common and special sensations.
3. Co-ordinated motion.
4. Mental faculties.
5. Co-ordinated *motion* and *emotion* (i.e. control).
6. Reproduction.

We may leave the trophic and reproductive function for the present, merely remarking that both may be precociously developed.

Unusually acute development of common and special sense functions, e.g. cutaneous sensibility and hypersensitiveness of sight, hearing, taste, and smell, may be important evidence of precocity (Bohannon) in very early days.

Development of co-ordinated motion and of mental faculties are closely allied. Each or both together may be precocious in development.

Finally there is a distinct type of precocity which consists in abnormally developed powers of control of emotional display, besides the better known type in which all emotions are excitable beyond control.

Order of Development of Mental Precocity

The order of appearance of mental precocity follows fairly closely that of normal development of faculties, namely, it is shown as regards (1) *Sense impressions.* (2) *Mental images.* (3) *Abstract ideas.*

Thus Sully concluded after investigating a large number of histories of musicians, painters, poets, novelists, scholars, scientists and philosophers, that their precocity varied in accordance with the degree of abstract thought required in manifestation of their special faculties.

Precocity was earliest shown with regard to *sense impressions* as displayed by musicians and artists, next in connection with *mental images* as seen in poets and writers of fiction, and latest in philosophers who deal with *abstract ideas.*

One may comment on this that artistic precocity in the technical sense implies precocity in muscular co-ordination. Yet the greatest musicians are not the best executants nor the greatest artists the most skilled draughtsmen.

Great composers of music and great artists must possess powers of imagination in addition to mere technique. Hence they are on a plane with poets, great writers of fiction, and even with philosophers.

Precocity may be evinced in all the capacities above mentioned in or out of their normal development, or it may apply to one alone or to all together.

At one end of the scale we may find a general and universal exaltation of all faculties—*Intellectus Universalis*—at the other there may be extraordinary development of one whilst all the rest are in abeyance.

The latter constitutes the *Idiots Savants.*

HAVELOCK ELLIS defines precocity as "an earlier than average attainment of the ultimate growth of maturity," but *does Precocity imply prematuration of intellectual function?*

There is a general impression that Prematurity is a necessary corollary to Precocity, that the precocious child rapidly reaches the prime of his mental powers and as rapidly declines. It is commonly predicted of a precocious child that he will "go up like a rocket and come down like its stick." He has been compared to the "early riser, conceited all the forenoon of life, stupid and uninteresting all the afternoon and evening."

Cases mentioned below, such as BARATIER'S and MONTCALM'S, and BEAUCHÂTEAU'S, seem to support the view that precocity is an actual condition of Progeria.

But, as we have seen, Precocity is by no means indicative of early disease, nor does it imply premature decay.

JASTROW concludes that his specially precocious class reach the period of original production much more speedily than other great men, but that they do not achieve a truly great success before other eminent men; furthermore, they reach the highest point of their development somewhat later, and do not live less long than eminent men in general. The average age at which their greatest work is produced is forty-seven as against forty-five for great men. He gives the following table to illustrate the productive periods and age at death in his specially precocious class, and in *Wunderkinder.*

JASTROW'S TABLE FOR SPECIALLY PRECOCIOUS GREAT MEN

	Artists and Musicians. (Precocity of Sense faculty.)	*Poets, Novelists.* (Imagination.)	*Philosophers Scientists.* (Abstract Thought.)
1. Age at production of first work	13·8	15·6	17·6
2. Age at production of first great work	28·0	27·8	32·1
3. Age at production of greatest work	46·7	43·9	47·7
4. Age at death . . .	60·1	61·6	66·3

FOR WUNDERKINDER

1. Age at production of first work	14·3
2. Age at production of first great work	25·6
3. Age of production of greatest work	42·1
4. Age at death . . .	56·9

Thus the average age at which the greatest work is produced by prodigies is about forty-two, whereas forty-seven is the age of ripest production in the case of specially precocious great men, whilst his average age at death, in *Wunderkinder*, is about six years earlier than that of specially precocious men of eminence. But it should be remembered that Jastrow's list of *Wunderkinder* only includes twenty in all, and the early deaths of some of them naturally lower the average of their lives in general.

LANCASTER'S *estimate of the average age* of *first success* is of interest.

Taking the average of one hundred *novelists* he found that the curve of success reaches its highest point between thirty and thirty-five years of age.

Averaging fifty-three *poets*, the age of most first poems published falls between fifteen and twenty.

The average age of first publications that showed talent he places at eighteen, which is in striking contrast with the average age of the first patent of *inventors* which is thirty-three years.

In *Music*, the average age at which marked talent was first shown is a little less than ten years; 95 per cent showed rare talent before sixteen.

Of fifty-three *artists* 90 per cent showed talent before twenty, the average age being 17·2 years.

Of one hundred and eighteen *scientists* Lancaster estimates that their life interest first began to glow, on the average, a little lower than nineteen.

In general he concludes that "those whose success is based on emotional traits antedate by some years those whose renown is more purely in intellectual spheres, and taking all together the curves of the first class culminate between eighteen and twenty."

His statistics do not show that the zenith of power was reached at the average ages mentioned, but only that the power was then manifested.

The *age at which Talent is most recognizable* according to Dexter, is about 46·7.

Professor Dexter, of the University of Illinois, has analysed between eight and nine thousand twentieth-century successes, and he finds them work out in this fashion:

Profession.	Successful men.	Average age.	Successful women	Average age.
Actor	54	30	40	25
Artist	260	40	21	40
Author	528	38	272	40
College Professor	1090	50	11	40
Editor	509	50	13	60
Inventor	26	55	—	—
Lawyer	857	55	4	45
Librarian	362	52	9	35
Musician	111	40	217	40
Physician	540	47	7	42
Scientist	416	58	7	50

St. James's Gazette, 27-9-'04.

We may conclude, therefore, that Precocity does not necessarily imply Prematuration, and therefore early decline of intellectual powers.

Were Precocity necessarily attended by Prematurity, and therefore by early mental exhaustion, all precocious children should die demented.

A Goethe or Young could not long survive his infancy.

On the contrary, it would seem that many who are precocious may live as long as others who are not, and that the precocious die of diseases which are common to all alike.

A delicate child may show the highest intellectual promise. The care and attention bestowed on him on account of his delicacy will tend to enhance his intellectual gifts, which again are fostered by the appreciation which he has for cultivating them. He cannot play like other children, and therefore he will think the more.

Should he, as any other child may do, succumb to Phthisis, Meningitis, or to disease of any kind, it is only natural that his precocity should bear the blame, although, in fact, such blame is based on fallacy.

Precocity in Special Lines

Sully, in his article on Genius and Precocity (*Nineteenth Century*, June, 1886), has collected and analysed 287 cases of musicians, poets, writers, scholars (including historians and scientists), and philosophers, in order to discover the proportion of those who are distinguished by special precocity.

In accordance with what has already been said, special precocity is shown earliest in regard to sense impressions, muscular co-ordination and imitation—as in the case of musicians and artists.

Musicians

Mozart played minuets at four and was exhibited as a *Wunderkind* a year later: early in his fifth year he composed concertos, at eleven an opera buffa.

Mendelssohn played in public at nine: his first dated work was a cantata written when eleven.

Beethoven began music in his fourth year; at nine he had outgrown his father's teaching. He is said to have written a cantata and certainly wrote compositions for piano at ten.

Schubert at eleven played the violin in church and composed songs.

Meyerbeer, as a young child, could play any air he heard. He performed in public at nine.

Heller did the same one year later.

Spohr played in public at twelve.

Rubinstein at ten.

Liszt at twelve.

Schumann composed before seven.

Cherubini at nine.

Auber at eleven.

Weber at twelve and produced his first opera at fourteen.

David composed at thirteen.

Lotti and **Rossini** at sixteen.

Purcell at seventeen years of age.

Out of forty names of musicians thirty-eight show decided bent for music before twenty; two names excepted are those of Palestrina and Tartini.

Twenty-nine of the thirty-eight are said to have shown musical gifts as young children. The others probably towards the end of childhood (about twelve).

In only two of the nine exceptions it seems that there was no marked manifestation of talent; these are Rossini and Wagner.

Rossini showed positive distaste for music until he was seventeen.

Wagner showed no particular indications for music until he heard Beethoven's symphonies at fifteen.

Painters and Sculptors

Precocity in painters and sculptors is almost as striking as in musicians.

I can only mention a few instances.

Sir **Thomas Lawrence** at the age of four showed such skill in drawing and so remarkable a memory that callers at his father's house were asked :

" Will you have him recite from the poets or take your portraits ? "

Sir **David Wilkie** could draw before he could read, and paint before he could spell.

Morland drew almost as soon as he left the cradle.

Canova drew as soon as he could hold a pencil.

Murillo and **Tintoretto**, as small boys, decorated the walls of their father's houses.

Mantegna at eleven was entered among the guild of painters.

Raffael, Tiziano, Michael Angelo, Holbein, Ruysdael, Van Dyck, Rubens and Correggio, all began early and showed their talents at once.

In Sully's list of painters and sculptors and architects, fifty-eight in all, he found that forty-two, or three in four, showed decided skill before the age of fifteen; sixteen between fifteen and twenty ; fifteen between twenty and twenty-five ; one between twenty-five and thirty ; one after thirty. Twenty-eight out of forty-two gained fame by their work before twenty-five ; nine before thirty.

Mathematicians usually show talent at an early age, for, as Aristotle said, " a boy can become a geometrician or arithmetician and can grasp these subjects philosophically . . . because the first principles of mathematics are self-evident" (*Ethics*, Bk. VI, SS. viii).

In many cases brilliancy in mathematics is part of the *Intellectus Universalis.*

A fair number of Senior Wranglers have also been senior classics.

There is a tradition that the late Professor Jowett was more distinguished in mathematics than in classics at St. Paul's School when he entered the sixth form at twelve years of age.

Specializing in such cases is merely a matter of individual taste.

On the other hand, it is certain that many minds of great general acuteness are quite incapable of grasping mathematical principles, not to speak of simple arithmetic and the multiplication table.

LEIGH HUNT said, "I never could learn it as a child nor do I know it now."

Mr. ANDREW LANG humorously, though no doubt with truth, relates his experiences of mathematics:

"By the cruelty of an effete University, I was doomed to master two whole books of Euclid or be ploughed in "Smalls." Nobody could teach me Euclid, still less Algebra. My brain and nervous system broke down; mine eyes were filled with childish tears. I sobbed hysterically. That way lay madness. Of arithmetic I was equally incapable. Buying a Colenso and a Euclid, and retiring into seclusion, I acquired arithmetic, to this extent, that I pleased examiners by triumphantly proving, 'Therefore a penny equals £240.' They let me through, none the less, perhaps allowing my Latin prose to compensate for my mathematical imbecility. I did know, for a week, two books of Euclid well enough to pass upon; Euclid, granting his premisses, is a logical and not uninteresting writer. But my youth was embittered" (*Longman's Magazine*).

Of precocious *Mathematicians* may be mentioned:

Guillaume de l'Hôpital, French mathematician: the first to write on Newton's Fluxions. He evinced a genius for mathematical study at an early age, and at *fifteen* solved a difficult problem of Pascal's.

Alexis Claude Clairant (1713–65), French mathematician, one of the academicians who went to the north to measure a degree with a view to ascertaining the figure of the earth, could read and write at *four*: at *nine* he had made some progress in algebra and geometry and had solved several difficult problems. At eleven he produced a memoir on curves, which appeared in the *Miscellanea Berolinensia* with an honourable certificate of the Academy of Sciences.

George Parker Bidder (1804–78), the celebrated calculating boy, showed as a mere child his extraordinary gift, which has perhaps never been surpassed by any who ever lived. It seems to have depended on a power of visualizing numbers, which was quite exceptional, although he believed it could be acquired by all.

Such powers of calling up symbol images or mental pictures are probably present in all mathematicians, and may be compared with the musicians' "tone images."

Gibbon and Porson seem to have shared this gift of mental arithmetic.

Laplace (1749–1827) was a mathematical teacher when a mere lad.

Frank D. Mitchell (*Amer. J. of Psychology*, January, 1907, p. 61) has collected twenty-four cases of mathematical prodigies.

His conclusions are that precocity in calculation is not an abnormal condition. Skill in mental calculation is independent of general education, and also of mathematical ability. Various mathematical and psychological short cuts explain the speed attained by some of the prodigies in mental operations.

Many calculators hitherto supposed to belong to the visual memory type are really of the auditory or audito-motor type at least in calculation.

But two and possibly four of the major prodigies belong to the visual type (cf. Drummond, *Rev. de Neurologie et Psychiatrie*, April, 1907).

Men of Science

The *Intellectus Universalis* is again noticeable in many men of science. The case of Thomas Young already related is an instance in point.

The special bent of men of science is often shown in mechanical or inventive precocity.

Mechanical Precocity

Galileo as a child made miniature models and repaired toys.

Ferguson made models of mills, spinning wheels, etc., and between seven and eight discovered independently the principles of the wheel and pulley.

Sir Isaac Newton constructed model windmills, water-clocks and sundials.

Robert Simson, the mathematician, also made a sundial as a boy.

Pascal invented his arithmetical machine at nineteen, and wrote a treatise on Conic Sections at sixteen.

Christopher Wren in his thirteenth year produced a new astronomical instrument dedicated to his father in a Latin address of eighteen hexameter verses. This was followed by an exercise on physics, on the origin of rivers, and the invention of a pneumatic engine.

Wren was not only an architect but Professor of Astronomy at Oxford.

Lord Bacon's delicacy as a child may have led to his love of sedentary pursuits, and the gravity which distinguished him from other boys.

As a mere child he tried to investigate the cause of an echo in a vault in St. James's Fields; at twelve he busied himself with very ingenious speculations on the art of legerdemain.

As regards mechanical ingenuity in early life, although in the cases mentioned it may be looked upon as precocity in invention, this is not always so. Deftness and skilful co-ordination of delicate hand movements is even met with in imbeciles. Many boys have a "furore" for constructing ships and engines without any remarkable success in doing so.

Any boy of nine or ten can take a watch to pieces, but one who can put it together again and make it go, unaided, deserves encouragement.

Precocity of Naturalists in their special line is often shown in a mania for collecting.

Darwin said (*Recollections of Development of my Mind and Character*): "The passion for collecting which leads a man to be a systematic naturalist, a virtuoso, or a miser was very strong in me."

At eight years of age he tried to make out the names of plants and collected all sorts of things—shells, seals, franks, coins and minerals—(cf. *Education at Shrewsbury*, p. 32).

William Smith, father of English Geology, wandered about as a boy collecting pound stones and "pan dips" and other stony curiosities.

Hugh Miller as a child accumulated stores of specimens of porphyry, mica, garnet, and such-like.

Edward Forbes (1815–54), Professor of Natural History at Edinburgh University, was possessed of a museum of natural curiosities by the time he was seven.

Frank Buckland's mania for collecting every kind of insect, bird, or animal, when a boy at Winchester is perhaps the best instance of a naturalist's precocity.

Audubon almost in infancy took a lively interest in ornithology.

Charles Waterton does not speak of collecting anything but birds' eggs but mentions that he began doing so when under eight years of age.

Humboldt, from his love of collecting and labelling plants, shells and insects, was known as "the little apothecary."

Agassiz at twelve was another boy collector; at fourteen he had fifty live birds in his room at one time.

Humphry Davy was another collector of minerals.

One cannot pretend that the collecting mania is peculiar to children who are precocious in any line. The majority of schoolboys collect something or other. It may be a passing hobby or an indication of future distinction.

Darwin modestly disclaimed any scientific method or particular intelligence in his mode of amassing his treasures, but his knowledge and accurate observation was shown in his recognition at the age of ten of various insects and moths in Wales which were not to be found in his native Shropshire.

Poets and literary men rank high in the matter of early production.

Tasso, of whose precocity wonderful stories are related, wrote his *Rinaldo* at his eighteenth year at latest.

Metastasio improvised in the streets and held a crowd as a child. At twelve he translated the Iliad.

Beaumont composed tragedies at twelve.

Abraham Cowley (1618–67), before he was ten, wrote an epical romance described as "the most astonishing feat of imaginative precocity on record," and was famous before he was fifteen. Few of us read him now.

Ovid wrote verses, and Ariosto dramas, in boyhood.

Pope wrote an "Ode to Solitude" and other poems before he was thirteen.

Chatterton—saddest example of genius thwarted—published at the age of ten his first poem on "The last Epiphany" in *Farley's Bristol Journal*, and in 1709 another poem "Elinoure and Juga," which he wrote at twelve, in *Hamilton's Town and Country Magazine.*

Calderon de la Barca (1600–81), the celebrated Spanish soldier, priest and dramatic writer, wrote his first piece at fourteen.

Giovanni Argoli (1609–60), a poet, published a poem on the silkworm before he was fifteen, and within two years another called "Endymion" in twelve cantos, which was written in seven months.

Carl Sprengel (1766–1833), a German botanist, physician and medical writer, produced a work entitled *Botany for Ladies* at thirteen. I am not aware that he showed other evidence of sexual precocity.

Goldoni produced a comedy in MS., which amazed all who saw it, at eight.

Polevoy, the Russian writer (1796–1846), whilst a mere child composed a drama, a MS. newspaper, and a history of Peter the Great.

Isaac Watts (1674–1748), a sickly child, was taught the learned languages at the free school of Northampton in his fourth year. He composed devotional pieces at seven or eight and spent all his leisure time reading, not playing.

Of Sully's list of fifty-two poets thirty-nine were distinctly precocious, four out of seven were famous before twenty-five, five out of seven by thirty, only four became so after forty.

Camoens, Goldsmith, Cowper and Wordsworth were late in revealing their gifts.

The youthful effusions of even the greatest have usually and perhaps wisely been suppressed, but most if not all great writers of fiction and poetry have practised early.

Dickens with his tragedy of "Misnar, Sultan of

India," SHELLEY with his mysterious alchemist, who lived in a castle, TENNYSON with his story of "The old Horse," which took weeks to relate, GEORGE SAND with her romances of Princes, and their adventures in trackless woods, delighted their small companions.

GOETHE, at fourteen, with seven languages in hand, invented seven brothers all over the globe and engaged in imaginary correspondence with them each in a separate tongue.

MACAULAY embarked on "A Compendium of Universal History" at seven, and at eight he wrote a "Treatise to Convert the Natives of Malabar to Christianity."

SCOTT at twelve began to invent stories and romances.

LYTTON published poems at fifteen and produced his first novel when twenty-two.

The BRONTËS almost as soon as they could read and write began to invent and act little plays of their own.

MADAME D'ARBLAY planned her novel, *Evelina*, when about fifteen.

Sully, in twenty-eight novelists, found in three out of four cases evidence of imagination showing itself before twenty.

Scholars and Historians

The *Intellectus Universalis* is usually apparent in these and their special lines follow individual tastes.

To GROTIUS reference has already been made.

PORSON at nine could extract the cube root of a number by mental arithmetic. Before fifteen he could repeat the whole of Horace, Virgil, and many parts of Livy and Cicero. His productive work began at twenty-four.

NIEBUHR showed at first a predilection for mathematics; at seven he was regarded as a model of erudition.

THIRLWALL was taught Latin at three. He began to compose at seven, and at twelve published his *Primitiæ*, which contained essays and poems on various subjects. Soon after twelve he wrote elaborate letters in Latin, showing extraordinary reading and critical judgment.

Sully concludes after examination of thirty-six cases that thirty, or five-sixths, were distinguished by preternatural ability, either in childhood or in early youth. About one-half showed at an early age the precise direction of their future activity.

The rest either proved themselves quick all-round learners or evinced exceptional intellectual strength in some other direction, e.g. mathematics or poetry.

Philosophers and Metaphysicians

Although as a general rule the faculty of abstract thought is developed later, or at all events displayed later than other faculties, there are many instances of precocity in their special line shown by philosophers and metaphysicians.

Berkeley conceived his principle of idealism at eighteen and published his new Theory of Vision at twenty-four.

Hume displayed speculative ability when very young. His mother described him as an " uncommon wake-minded lad."

Leibnitz, like Mill, was a prodigy of youthful learning, and showed a philosophic bent at fifteen in his criticism of the doctrine of " *substantial forms*."

Schelling had written three philosophical works before he was twenty.

Sully's conclusions are that out of thirty-six cases two wrote on philosophical subjects before the age of twenty ; eighteen between twenty and thirty ; eight between thirty and forty ; and eight after forty.

Kant's first independent treatise appeared at the age of forty-six. After fifty we find such names as Descartes, Hobbes and Locke.

Linguists and Scholars

The ground work of the linguist or scholar is a phenomenal memory, delicacy of ear and great imitative powers. These qualities, coupled with immense powers of industry and application, go far towards the making of a genius, but the common expression " dry as dust " applied to the scholar implies that he is often deficient in imagination.

Any child with imitative powers and accurate ear can pick up foreign languages with ease, and like a courier can prattle many tongues with more or less inaccuracy, but he is not necessarily a phenomenon on that account.

Yet, a passion for acquiring languages may be precocious, and indicate a tendency to specialize in that direction, whilst other faculties are apparently uncultivated.

" *Genius born to Eternity.*" *Memory*

Gaspard de Barthius (1587–1658), Scholar: editor of editions of Virgil, Claudius, Statius, etc., in all of which he displayed prodigious learning as well as extraordinary powers of memory, having generally quoted the passage he was commenting on from memory.

He early became such a *master of languages* that while yet a boy he translated Comines and thirty romances from French, Spanish and Italian into Latin, besides rendering seventeen psalms into different kinds of Latin verse when only twelve years of age.

Scaliger said of him that there was in Barthius another genius born to eternity, and should he live, sound learning would be preserved for a time.

Orientalists

James Claudius Rich (1786–1821). Eminent Oriental scholar, was Resident of East India Company at Bagdad, 1808, and made valuable collection of MSS., gems and coins from Nineveh, Bagdad and Babylon, now in British Museum. By the time he was fourteen he had acquired Arabic, Hebrew, Persian, Syriac and Turkish.

Antoine de Sacy. French Orientalist, keeper of Oriental MSS. in the King's Library under Louis Philippe, wrote many important works, and through him, professorships of Hindustani, Sanscrit and Chinese were established at Paris in 1758–1838. He was delicate and therefore educated by a tutor. "At a very early age" he was proficient in Greek and Latin, and in his twelfth year, through influence of a Benedictine monk, studied Eastern languages, Hebrew, Arabic, Chaldee, Samaritan, Syriac and Ethiopic, also English, Spanish, German, Italian and Latin, Persian and Turkish.

Classical Scholar at Fifteen

Villoison, eminent French scholar (1750–1805). Appointed Professor of Ancient and Modern Greek in the College of France by Napoleon.

By the time he had reached his fifteenth year, had read nearly the whole of the Greek writers.

His name became known throughout Europe as a marvel of learning.

Precocious Memory

In some cases precocity is due simply to an extraordinary memory, and imitative power, shown especially in the faculty of acquiring languages.

When other faculties are not developed in proportion eminence in after-life is seldom achieved. Memory is the foundation of scholarships and the secret of brilliancy in school examinations. It is often mistaken for budding genius.

It is true that no great man ever had a bad memory, but good memories alone do not make great men.

Darwin said of himself, " My memory is extensive, yet hazy; it suffices to make me cautious by vaguely telling me that I have observed or read something opposed to the conclusion which I am drawing, or on the other hand, in favour of it; and after a time I can generally recollect where to search for my authority. So poor in one sense is my memory that I have never been able to remember for more than a few days a single date or a line of poetry."

In another passage he says he could learn forty or fifty lines of Virgil or Homer whilst in morning chapel at school, " but this exercise was utterly useless, for every verse was forgotten in forty-eight hours."

It is possible that Darwin with characteristic modesty underrated his powers.

At any rate he possessed the memory for references which is often a great consolation to those who are hazy as to facts.[1]

Some remarks which Darwin makes on himself in boyhood may be quoted here.

" The only qualities," he says, " which at this period (school) promised well for the future were, that I had strong and diversified tastes, much zeal for whatever interested me, and a keen pleasure in understanding any complex subject or thing." He speaks of the intense satisfaction which the clear geometrical proofs of Euclid afforded him, and also the delight which his uncle gave him in explaining the principle of the "vernier" of a barometer.

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[1] Cf. Dr. Johnson. " Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information on it " (Boswell: *Life*, Standard Lit. Ed., p. 225).

ARNOLD of Rugby at three knew all the stories connected with the various reigns of the Kings of England.

MACAULAY at the age of four was taken to the Orford Collection and remembered the catalogue ever afterwards.

CUVIER at twelve is said to have remembered most of all he saw and read.

EDISON at ten to twelve could refer usually to the very book and page, to fact, incident, and words used by certain authors who impressed him.

FICHTE and WILLIAM WOTTON could repeat a sermon word for word after once hearing it.

ANTOINE ANSELME (1652–1737), at the age of twelve could do the same. He was known as "The little Prophet" from the tender age at which he preached his first sermon. He was so popular a preacher that his engagements to hold forth were made four or five years in advance.

Memory and *imitativeness*, no doubt, have much to do with the sensational performances of child evangelists at the present day.

GOETHE, SHELLEY, WATT, MACREADY, JOHNSON, ABRAHAM LINCOLN, GIBBON and NAPOLEON were all endowed with prodigious memories.

A naturally receptive mind is never over-filled—a retentive memory cannot be made less so except by disease or natural decay.

Memory is a natural gift which all great men possess and others cannot gain. Its exercise is effortless; although fatigue may result from disgorging facts on paper for many hours at a time.

To a Goethe who could pick up Italian from hearing his sister taking lessons in the language whilst engaged himself in committing other matter to memory, to a Johnson who when in petticoats could learn a collect whilst his aunt was going upstairs; to a Porson, a Macaulay or a Mill, no learning is a tax on memory.

A retentive memory, a power of absorbing knowledge and an accurate observation, are the backbone of genius on the scientific and philosophic side.

But such a backbone is weak without the magic influence of imagination, of zeal and enthusiasm, of concentrated thought, of inference and generalization from facts.

Anyone may collect facts, but it needs a genius such as Bacon, Harvey or Darwin to elucidate them.

It is only a Plato who, after building his model state, can in it spy justice rolling at his feet.

Awakening at Adolescence

LANCASTER collected over a thousand biographies, from which he took two hundred for careful study, choosing them to show different types of activity.

Of these one hundred and twenty showed a distinct craze for reading in adolescence; one hundred and nine became great lovers of nature; sixty-eight wrote poetry; fifty-eight showed a great and sudden development of energy; fifty-five showed great eagerness for school; fifty-three devoted themselves for a season to art and music; fifty-three became very religious; fifty-one ran from home in their teens; fifty-one showed dominant instincts of leadership; forty-nine had great longings of many kinds; forty-six developed scientific tastes; forty-one grew very anxious about the future; thirty-four developed increased keenness of sensation or at least power of observation; in thirty-two cases health improved at adolescence; thirty-one became passionately altruistic; twenty-three became idealists; twenty-three showed powers of invention; seventeen were devoted to older friends; fifteen would reform the world; seven hated school.

Sully's Conclusions

Sully's main conclusions from study of his 287 cases divided into seven classes are that four-fifths, or 231, displayed talent before the age of twenty.

The rest he regards as exceptions to the general rule that all men of great genius give early manifestations of brilliancy.

Jastrow's Criticism of Sully

Jastrow (*Journal of Education*, July, 1888) thinks that Sully is too lenient in his criterion of pre-eminence.

He selects ninety names of world-wide fame out of Sully's 287 cases and distinguishes, in these ninety cases, special from ordinary precocity.

Special precocity he defines as:

" An unusually early and very pronounced evidence of special gifts, including at the upper end of the scale the *Wunderkinder* of the world, and at the lower a somewhat less degree of the same manifestation, but including none that could not of themselves attract great attention."

He concludes that one in five of Sully's 287 cases are specially precocious, whereas Sully places four in five in the same rank.

Wunderkinder appear in a proportion of about one in fourteen or fifteen of 287 great men selected.

Jastrow, however, agrees with Sully that there is a general relationship between intellectual eminence and precocity.

Galton also maintains that few who possess very high abilities can fail in achieving eminence—unless they lack zeal and necessary capacity for work.

He does not enquire very closely into the age at which precocity in eminent men was first manifested, but notes that it was extremely early in some ninety-two cases.

Leaders of Men

History is singularly silent as regards the early precocity shown by statesmen, politicians, soldiers and sailors, but now and again they showed glimpses of their future career.

Thus, we hear of Lord Clive, fierce and imperious as a boy; leader of a band of hooligans who levied tribute on the shopkeepers; climbing Market Drayton steeple; idle at school, yet leading one of his masters to prophesy that he would make a great figure in the world.

WELLINGTON was too delicate to play at school but superintended the games of other boys, rigidly insisting on the observance of rules and fairness.

WILLIAM THE CONQUEROR drilled his little army at the age of five.

NELSON'S remark to his mother: "What is fear? I never saw it" is suggestive.

CANNING, again, never played at games like other boys, but at twelve "assumed at once the sober dignity of manhood."

Idiots Savants

As a rule I believe that pre-eminence in any special line is associated with generally high ability, but there may be exceptional cases in which this is not so.

Idiots Savants, as Dr. Langdon Down has observed, may show remarkable aptitude for mental arithmetic and calculation, great mimetic faculty, special keenness in sense perception, manual skill and dexterity and musical ability.

It may, therefore, be that children accounted dull in ordinary school life may still possess some dormant faculties which remain in abeyance until accident awakes them or opportunity allows their play.

Some of Dr. Langdon Down's cases possessed an astonishing memory for figures, dates and past events. One could recite all the answers in *Magnall's Questions* without an error, and repeat from memory anything he had read, simply by a process of verbal adhesion. Another knew tune, words and number of nearly every hymn in "Hymns Ancient and Modern." Another could tell the time to a minute at any part of the day, although not understanding the use of a clock face. Others showed extraordinary capacity for music, or such skill in mechanics that hopes of turning it to account were entertained.

Sooner or later it is discovered that these unwonted developments of a solitary faculty are associated with general mental enfeeblement not previously suspected, and end in early decay or possibly in death.

This may account for the prevalent belief that the wise die young.

Perhaps the most remarkable example of the musical *Idiot Savant* is that of Blind Black Tom, of Boston, Massachusetts, of whom there is an interesting account in *All the Year Round*, October 18th, 1862, p. 126.

He was born a slave in Georgia in 1850 and was a blind imbecile of the lowest negro type, coal black, with protruding heels, ape-like jaw, and blubber lips constantly open.

At the age of seven he was heard imitating on the piano music played by the daughters of the house with wonderful accuracy, although he had never had a lesson in his life. Thenceforth he was allowed free access to the piano, although incapable of receiving scientific instruction.

At twelve he was exhibited all over the States as a musical prodigy.

Although only one degree above an idiot, incapable of understanding the simplest conversation and like a child of three in conduct, he had a large repertoire of classical and operatic music which he played entirely by ear. He could reproduce any piece of music after once hearing it played, and could even supply the bass to the treble of music heard for the first time.

His execution was marvellously facile, and as a *tour de force* he would play seated with his back to the keys.

His memory in other respects was phenomenal; like Fichte he could repeat a discourse of fifteen minutes in length without loss of a syllable—yet without understanding a word of it. It was purely an auditory memory and a matter of verbal adhesion, and may be compared with the visual memory or power of visualization of figures which accounts for the feats of "calculating prodigies."

Precocity in this instance was that of sense impressions, muscular co-ordination and memory.

He was passionately fond of music, and would improvise after a fashion, but his productions were apparently of no merit—probably they consisted of scattered reminiscences.

I do not know what became of him—probably he died young, for he seems to have been overworked, showed signs of exhaustion and sometimes epileptic fits as the result of his performances.

We may now consider the questions, "*Is precocity a pathological condition? and does it tend to early death?*" Such sayings as:—

"*Il ne vivra pas, il a trop d'esprit.*"

"*Kluge Kinder sterben früh.*"

"*Immodicis brevis est aetas et rara senectus.*"

"*Illud ingeniorum velut praecox genus non temere unquam pervenit ad frugem*" (Quintilian, *Inst. Or.*, I, 3, 3).

"Whom the Gods love die young."

"So wise so young they say do not live long." (*Richard III.*)

"Early ripe, early rotten."

are sufficient to show that precocity has been regarded as of evil omen in most countries and as a warning of early decease. There is always some foundation for popular beliefs. It is never safe to disregard them.

Such views are shared by Alienists. Thus CRICHTON-BROWNE says:—

"Precocity may generally be looked upon as expressive of disease"; and again, "We look upon it as a morbid psychical condition generally terminating in the worst results."

CLOUSTON says, "Child musicians and child poets are more or less pathological."

BAUR says, "All mentally precocious children, according to the ordinary use of the term, are pathological and mentally diseased."

LUDWIG CERNEJ thinks that precocity is usually pathological.

CHRISTIAN in one hundred cases of *dementia precox* found that twenty-two had given unusual promise of mental ability.

MORELS noted that most of his patients suffering from *dementia precox* had been unusually bright in school work.

LOMBROSO regards precocity as "morbid and atavistic."

SAVAGE says, "Special capacity or genius whether it be on the mental or even muscular side is associated with danger" (*Lumleian Lectures*, 1907).

I may first refer to the most remarkable cases of precocity as seen in *Wunderkinder*.

In all recorded instances a certain allowance must be made for exaggeration and fable. One does not believe, for instance, that Tasso uttered words at six months, that the wise child of Lübeck had mastered the Old Testament by his first birthday, that Confucius was created a Mandarin in his third year, or that the learned Lipsius composed a work on the day he was born.

Yet, allowing for all exaggerations, accounts of most of the *Wunderkinder* seem in the main authentic.

I have already alluded to some of the *Wunderkinder* who grew up, and may now mention *Infant Prodigies who died young.*

Christian Hemerken, the learned child of Lübeck, was born in 1721. Long before he had reached his third birthday he was familiar with the religious history of the world, and could discuss abstract questions of dogma with marvellous eloquence and learning. He was intimately acquainted with history and geography, ancient and modern, sacred and profane, besides being able to speak French and Latin.

He died at the age of four (*Encyclopædia Britannica*).

Jean Philippe Baratier was born in the same year as the above. Before he was five he had mastered Latin, French, Dutch and Greek, and three years later could translate the Hebrew Bible into Latin and French. At thirteen he became M.A. at Halle, and was received into the Royal Academy at Berlin. At nineteen he died.

John Evelyn's "most deare child Richard," who died January, 1658, aged five years and three days, "was both in shape and countenance and pregnancy of learning next to a prodigy." Evelyn in his diary gives a most pathetic and interesting account of this little boy's piety and extraordinary acquirements. He attributed his death at the time to the over-zealous treatment of women and maids, who baked him in a cradle near an excessive hot fire in a close room, whilst suffering from quartan ague. But thirty years later he seems to have thought that precocity had a share in causing the child's untimely decease, for in 1689 he warned Dr. Clench, the father of another learned infant, "not to set his heart too much on this Jewell"

(*Evelyn's Diary*, p. 527. Chandos Classics). After his death he was found to be " what is vulgarly called *liver growne*."

Montcalm, born 1719 at Candrai, near Nîmes. At fifteen months, before he could speak, he knew the alphabet, that is he could point with his finger to any letter he was asked for. In the middle of his fourth year he translated the whole of Cornelius Nepos, and before five he took all the first prizes in his class.

At seven he knew arithmetic, geometry and ancient history. A year later he was known as a good mathematician and archæologist. At thirteen he was crowned by the Academy of Nîmes and given the title of Savant. He had scarcely entered his fourteenth year when he was seized with some wasting malady, and he died next year almost in a condition of imbecility.

François de Beauchateau, born 1695, could read, write and calculate at the age of five. He showed a marvellous aptitude for the liberal arts : his tastes led him towards drawing, painting, music and poetry. At ten he made a name as a poet, his verses were printed in the *Mercure Galant* (cf. Chatterton). His reputation soon filled the capital. Anne of Austria, mother of Louis XIV, and Mazarin saw this living phenomenon and were astounded at his talents and mental powers. He died at thirteen of a " rachitic condition."

The famous Pico de la Mirandola knew twenty-two languages at eighteen. He could repeat a book from end to end after hearing it read once. At twenty-three he knew practically all there was to be known.

At twenty-four he went to Rome and offered to sustain a thesis on any subject whatever. He was coldly received, became piqued and shut himself up in one of his chateaux, where he died at twenty-nine or thirty (*Histoire naturelle de l'homme et de la femme*, par A. Debay, Paris. E. Denter).

Instances of *Wunderkinder* who died young might be multiplied, and they tend to support the popular belief that all mentally precocious children are prone to early death.

Yet cases to the contrary abound in history. Indeed, the evidence is strongly in favour of the view that all the greatest men in the world have been drawn from the ranks of the precocious, and that the lives of these have not been below the average duration. In other words all genius and great intellectual ability is precocious.

Jastrow divides his specially selected cases (ninety in all) of precocity into three groups in accordance with their special bent or talent.

The average age of death of those whose life called into play :

Sense activities	was	60·1	years
Imagination	,,	61·1	,,
Abstract thought	,,	66·3	,,

The average age at death of *Wunderkinder* (twenty selected cases) was 56·9.

Jastrow's standard of " special precocity " is arbitrary and perhaps exacting, although Sully's may be too lenient.

Also his number of *Wunderkinder* is small (twenty in all), yet I think the list might be considerably extended without affecting Jastrow's statistics, and this is remarkable because the inclusion of all undoubtedly precocious children who are known to have died young would naturally tend to lower the statistics of average duration of *Wunderkinder's* lives.

Physical Correlation of Precocity

In accordance with the prevalent belief that " those whom the Gods love die young " is the notion that great men are always delicate.

Havelock Ellis (Study of British Genius) found that out of 1030 cases, 110 or about 10 per cent were extremely delicate in infancy or childhood.

Six were seven months' children or premature, fourteen were very weak at birth and not expected to live.

Sir Isaac Newton, for example, was so small at birth that "a quart mug would have held him."

Voltaire's nurse for several months after he was born used to come daily to tell his mother that he was really dying.

Goethe at birth was not expected to live.

Jerome Cardan, the celebrated mathematician and physician of the sixteenth century, had to be resuscitated after birth "in a little bath of wine," and was delicate throughout his childhood.

Gibbon in infancy was of feeble constitution and his life was precarious.

Victor Hugo's mother described him as "no larger than a knife."

Demosthenes was a weakling and so tender in early childhood that his mother would not let him go much to school, nor did his masters dare to keep him hard at work.

Descartes was "a sickly young philosopher at eight."

Albert v. Haller (1708–77), the pioneer of physiology, Wellington, Lord Bacon, Locke, Swift, Watt, Canova, Alexander Hamilton, Schiller, Niebuhr, Byron, Johnson, Scott and Dickens were all delicate as children—William Pitt from his schooldays was cruelly tormented by gout, perhaps induced by Dr. Addington's prescription of "floods of port wine."

On the other hand, Tennyson, Longfellow, Edison, Abraham Lincoln, Bismarck, Russell Lowell, Emerson showed a natural and healthy development.

In some cases early delicacy was followed by exceptional physical health and vigour. BEETHOVEN, BURKE, CONSTABLE and HOBBES are examples.

Sometimes illness or feebleness of constitution has given the impulse to mental activity. CHARLES DICKENS, for instance, said that his ill-health in his younger days inclined him to reading.

JOSEPH PRIESTLEY believed his early sickness was an advantage to him, holding that health and high spirits were unfavourable to the sensibility of mind necessary to piety and speculative pursuits.

Enforced rest has no doubt given the impulse to learning in naturally clever children, and hence the general impression that active minds inhabit frail bodies.

Galton remarks on this point: "There is a prevalent belief that men of genius are unhealthy, puny beings—all brain and no muscle, weak-sighted and generally of poor constitution. I think that most of my readers would be surprised at the stature and physical frames of the heroes of history who fill my pages, if they could be assembled together in a hall."

He concludes that "among the gifted men there is a small class who have weak excitable constitutions, who are destined to early death, but that the remainder consists of men likely to enjoy a vigorous old age."

Jastrow, as we have seen, finds that his specially precocious cases do not live less long than great men in general. The fact that many eminent men such as CICERO, WAGNER, DARWIN, HUXLEY, CARLYLE, have suffered a lifelong martyrdom from chronic nervous dyspepsia, does not prove that ill-health is a necessary relationship to mental vigour.

As Galton says, again, "I do not deny that many men of extraordinary mental gifts have had weakened constitutions, but deny them to be an essential or even usual accompaniment."

Yet there is, no doubt, a normal relation between mental and physical development and truth in the saying "Mens sana in corpore sano."

The Medical Officer's "Report of the Education Department of the London County Council for the year 1906" gives a table showing the heights of boys and girls in London schools distributed according to standards and arranged in groups.

The 12 per cent of dullards noted are seen to be nearly all below the mean height, whilst 2 or 3 per cent of exceptionally clever or precocious children are generally above the mean. At any given age the taller children are found in the higher standards, and a group of children at any age and in any standard generally averages less height than the groups of children in higher standards, but one or more years younger.

These results are confirmed by PORTER's measurements of St. Louis children, and also by OCBBECKE of Breslau, who taking half-yearly groups, which diminishes the risk of error, finds that there is a relation between height, weight and mental equipment. BOAS, however, of Toronto, from similar investigations came to an opposite result. BOHANNON, in his interesting study of peculiar exceptional children, comes to the conclusion, as to general health and mental ability, that the larger children—excepting extremes—are superior to others (R. Langdon Down).

As instances for comparison with these results may be mentioned that BISMARCK, DARWIN, DUMAS EMERSON, GOETHE, ABRAHAM LINCOLN, J. S. MILL, SCHILLER, SHELLEY, TENNYSON, VOLTAIRE, WASHINGTON, WELLINGTON, and RICHTER, were all tall men.

GEORGE ELIOT, KINGSLEY, and RUSSELL LOWELL were of medium size.

NAPOLEON, GIBBON, and HARVEY were short statured. NEWTON was short and thick-set. DE QUINCEY and HARTLEY COLERIDGE were diminutive.

Fondness for Games and Sports as evidence of Health and Strength

Washington had a passion for active sports such as running, jumping, wrestling, etc.

Jefferson hunted, rode and swam. Schiller was a leader in sports. Stevenson was fond of athletics. Byron and Darwin were fonder of sport than study. Hamilton, Garibaldi, Longfellow all liked games. Lincoln was the champion wrestler and wood-cutter in his district. Not a few of our most distinguished judges have been athletes at their universities.

On the other hand, many eminent men have, like Themistocles and Canning, never played at games like other boys.

Yoder found that about half of his list of eminent men were fond of some kind of sport and excelled in it.

He noted some cases of delicacy in early childhood in fifty selected cases, but concludes, like Galton, that the idea that great men as children have been weak in greater proportion than other children, sickly and inactive physically, is erroneous.

Is Precocity an indication of future Insanity?

It must be admitted that the views of Alienists have evidence to back them.

Two historical cases in point are classical—Lope de Vega Carpio and Torquato Tasso.

Lope de Vega Carpio (1562–1635). His precocity was extraordinary. At five he read Spanish and Latin, and showed such a passion for poetry that he would give up part of his meals to other boys in exchange for their services in writing out verses at his dictation. He was educated by the Jesuits at the Imperial College of Madrid, where, lest he should become a pedant, he was taught singing, drawing, and fencing, besides ordinary lessons.

After a very varied career, he spent his last years in severe self-inflicted penance, with frequent scourgings (*Ency. Brit.*) In other words he suffered from religious melancholia.

Tasso (1544–95), again, was a *Wunderkind.* At three he began to study grammar. At four he went to the College of the Jesuits. At seven he was well acquainted with Latin and Greek, made public orations in a style which is said to have had nothing of puerility. At twelve he had complete knowledge of Latin and Greek, the rules of Rhetoric and Poetry, and was versed in Aristotle. At thirty he became insane.

Cowper, again, suffered from religious melancholy.

Jerome Cardan in his old age had delusions of persecution and of possessing a familiar spirit.

Some men of genius have become addicted to alcoholism and drug-taking, like Poe, Burns, the Coleridges —father and son—De Quincey, Morland, and Rembrandt, and therefore might be regarded as insane.

If eccentricity, waywardness and unconventionality are evidence of insanity, a large number of geniuses have been mad.

But melancholy, delusions, narcomania and eccentricity do not occur exclusively in men of genius, or in men of high ability who have been precocious.

Granting that all insane geniuses have been precocious it does not follow that all precocious children are in danger of becoming insane.

The Alienist's experience is confined to those who do become so.

So far I have attempted to show :

1. That mental precocity in itself is not a morbid or abnormal condition, but an early manifestation of intellectual gifts above the average.

2. That precocity does not imply prematurity and

early decay of intellectual powers, nor a life of less than average duration.

3. That precocity may be general or special.

4. Those possessed of the *Intellectus Universalis* may show general all-round brilliancy in childhood and in after life or may specialize in accordance with their individual tastes. The greatest geniuses have probably been of this class.

5. Special precocity is shown earliest in respect to sense impressions and muscular co-ordination as in the case of musicians and artists. It is early in mathematicians and inventors and men of science. Somewhat later, though still early, in those of highly developed powers of imagination and mental energies—poets and writers of fiction. Latest in those whose work demands abstract thought—philosophers.

6. A prodigious memory, auditory or visual or both, with power of calling up sense images at will, is characteristic of genius of any kind, but does not in itself constitute genius.

7. All geniuses and persons of marked ability have been precocious, although their precocity may have been unrecognized.

As already stated, there is always some foundation for popular beliefs. No one doubts that many precocious children have died young, but as we have seen, there is not sufficient evidence to show that precocity caused their early deaths.

Similarly although precocity does not imply early decay, it cannot be disputed that precocious children often do not fulfil the promise of their youthful days, and that there is some ground for the popular belief that clever children make dull men. We have now to consider the

Causes of Failure in the apparently Precocious

The question, what proportion of precocious children meet with success in after life admits no complete answer.

A genius is known to the world not by what he is but by what he does. We should not know him at all as a genius unless he achieved something great, whereas we are all familiar with cases of seemingly transcendent mental gifts and abilities in those who never do anything at all to bring them into fame.

Assistance in dealing with this question is gained by consideration of some of the qualities of genius itself, of the conditions under which it flourishes, the difficulties with which it may have to contend and its behaviour under them.

Versatility v. *Volatility*

The versatility of a genius may seem to be shared by one who is not a genius, but the former finds his special bent and clings to it, whereas the latter flits from subject to subject and may not gain renown. Versatility in the one is replaced by volatility in the other.

Again, the special bent of genius may be mistaken at first, or thwarted by design or circumstances. Genius overrides the difficulty, but the merely brilliant intellect may resign itself to fate, or fret itself out in vain and futile struggles against environment.

The emotional side of genius has again to be considered in relation to those who share its overwhelming excitation, and perhaps its intellect, without the other qualities which render genius all-powerful.

Egoism, self-consciousness and introspection, pride and vanity are characteristics of certain types of genius, but these qualities without genius are almost bound to lead to failure.

Mistaken Bent

Considering the versatility of genius, it is not surprising that in some cases more than one line may be taken up before the final choice is made. I may give a few instances in point.

LUCIAN tells us in his *Visions* that as a small boy he used to be punished at school for stealing the wax from his writing tablets in order to mould small figures of animals and men and women. His parents assumed, therefore, that he was destined to become a sculptor and apprenticed him to his uncle, who happened to be one. The apprenticeship lasted one day. At his first attempt he broke a valuable plaque with the chisel. His uncle flew into a passion and beat the boy, who ran home weeping, declaring that his uncle treated him in this manner out of envy at his superior skill.

That night he had a dream in which Culture and Statuary appeared and invited him to choose between them. Not altogether without bias, he favoured culture, and hence we have his immortal dialogues.

GALILEO (1564–1642), as a youth was an excellent artist; then thought of devoting himself to painting, but when he was seventeen he studied medicine, and at the University of Pisa he fell in love with mathematics.

BILLROTH the surgeon (1829–94), as a youth desired to devote himself to music for life. He felt himself to be "truly a child of music and the stage." Surgery was his destination but he ever retained his passion for his first love. His book *Wer ist Musikalisch* is an elaborate study of musical psychology.

RUYSDAEL, although showing remarkable artistic ability at fourteen, was a surgeon before he became an artist.

KEATS was a L.S.A. and SMOLLETT a medical practitioner.

SIR WILLIAM HERSCHELL was educated as a musician.

JOHN LOCKE was not only a metaphysician, but a capable physician, the friend of Sydenham. He diagnosed an Hepatic abscess in Lord Shaftesbury when others had failed to do so, and saved his life by operation (Lewes, *Life of John Locke*). Cf. Osler's *An Alabama Student and other Biographical Essays*. Oxford, 1898.

OLIVER GOLDSMITH was a conspicuous failure as a doctor.

Berlioz at first studied medicine.

Two of our greatest etchers—Seymour Haden and Propert—also practised medicine.

Claude Bernard before he was twenty-one wrote a successful comedy and a five-act drama. He was dissuaded from literature as a profession by Girardin. Then he took to medicine.

Rabelais was first a Monk, then Physician to the Hôtel-Dieu. It has been stated that he began to compose his *Merry Tales* with a view to relieving his patients' monotony whilst enduring bath cures.

Thwarted and Unrecognized Bent

The *Intellectus Universalis* usually meets with prompt appreciation in children, and seldom lacks encouragement, but the precocity of genius in special lines has often been discouraged or unseen.

Handel's father sent all musical instruments out of the house to keep his child from playing.

Bach's early compositions were destroyed by his elder brother in order to discourage him.

Robert Schumann abandoned Law for Music against his parents' wish.

Cellini's father, a musician, tried to make Benvenuto a flute-player whilst he yearned to chase his glorious golden chalices.

Tycho Brahe was sent to study Law at sixteen, but managed to conduct his astronomical pursuits after office hours.

Rubens, who took to painting at thirteen, had to put up with the distress of his mother, who deemed him worthy of a higher calling.

Sir Joshua Reynolds' father wished him to become a medical man, and rebuked him as a child for neglecting his lessons and taking pleasure only in drawing.

Hogarth was considered very dull at his lessons, but embellished all his books with illustrations.

JOHN HUNTER nearly became a cabinet maker.

J. H. VON KLAJROTH (1783–1855), became a distinguished Oriental scholar and linguist. His father, a scientific chemist, educated him to become one also, but at his examination when about fifteen he did so badly that the professor said to him, "Sir, you know nothing!" to which he replied, "Excuse me, I know Chinese." He had learnt the language without any assistance.

Precocity of Reticence

There is such a thing as Precocity of Reticence which may simulate dulness in the eyes of unobservant teachers and parents. Silent children are often accounted stupid, but those who talk least often think most, and their thoughts may be worth more than pennies.

Precocious reticence is often, especially in imaginative, philosophic, and scientific minds, associated with dreamy mental states, inability to descend to the "trivial round and common task," and unsociableness.

Precocious children of the reticent dreamy type may share the fate of Balzac, and not the good fortune of Descartes and Cowley.

The habit of taciturnity and of restraining all outward show of emotion is common in nervous subjects, and may be taken to indicate dulness.

HARRIET MARTINEAU was considered extremely stupid as a child owing to sheer nervousness, and her habit of concealing the fears of imagination which haunted her.

A desire for Solitude and Unsociableness seems to be a Common Trait.

MILTON in *Paradise Regained*, I, 201, says :—

> "When I was yet a child no childish play
> To me was pleasing; all my mind was set
> Serious to learn and know, and thence to do
> What might be public good; myself I thought
> Born to that end, born to promote all truth,
> All righteous things."

Sometimes a desire for solitude proceeds from timidity and dread of noise in delicate children. Sometimes it is from proneness to indulge in reverie and day-dreams and in communings with nature.

Johnson sauntered in the fields in childhood, dreaming and talking to himself rather than to his companion.

Darwin, in a brown-study, stepped over the city wall of Shrewsbury and nearly broke his neck.

Wordsworth mused alone in the twilight glens, and Byron in the abbey cloisters. Shelley communed with the stars and moon.

George Sand had a secret hiding-place in the woods in which she erected an altar and performed thereon solemn strange rites, setting at liberty butterflies, lizards, green frogs, and birds in the name of her new deity Corambé.

Sir James Mackintosh at eleven loved solitude, and used to dream that he was Emperor of Constantinople.

The elder Coleridge wandered in the streets imagining himself Leander swimming the Hellespont, and as his spreading hands touched a passer-by he narrowly escaped arrest as a pickpocket.

Hartley Coleridge, his son, was intensely sensitive, impatient of control, shy and awkward to excess, insignificant in personal appearance and infirm of will. At school he never played, but passed his spare time reading, writing, dreaming to himself and telling his dreams to others.

Wagner, in the fits of gloom and depression which seized him as a lad, would hide himself and cogitate alone for hours together.

Some of these silent, solitary children have the faculty of conjuring hallucinations at will before their eyes.

Jerome Cardan as a child amused himself by watching phantom figures of priests, animals, trees and flowers, etc., which seemed to pass in endless procession across his bed.

Henry Morley, who wrote a life of Cardan, refers to a similar habit of his own, and a modern instance charmingly related is found in Jules Breton's *Vie d'un artiste.*

It is characteristic of such children that they always keep their visions to themselves.

Aristotle said of the man who seeks solitude, "Ἢ θεὸς ἢ θηρίον"—he is either a God or a beast.

Some schoolmasters of the present day are in the habit of assuming the latter, and suspect any boy who is solitary and muses and will not join in games, of being addicted to secret vice.

The principle "either play or work" saves the schoolmaster a great deal of trouble, but it is not applicable to all alike.

The precocity of reticence, the critical instincts, the dreamy mental states, and desire for solitude in clever children may be mistaken for sloth and indolence, especially when interspersed with occasional flashes of ability.

Some quietly and imperturbably follow their bent, and assert themselves in spite of injudicious treatment. Tamer spirits give in, are spurred to make superhuman efforts to excel in lines which do not suit them—and fail.

The emotional side of genius and precocity has an important bearing on success and failure.

Genius on the artistic side is inseparably related to emotional activity.

The true artist, musician, poet, and writer of works of fiction and imagination are all alike inspired by the quickness of their emotions. Precocity on the emotional side is always present in them.

Those who are of the so-called artistic temperament, whether musicians, poets, or writers of fiction, have been in many cases notoriously unstable in character, unbalanced in mind, and swayed by every emotion and idea which they portray.

They have been prone to fits of wild elation and deep depression, childishly vain and exacting, selfish and faithless, unbridled in their appetites and desires, moral and physical cowards.

Their genius consists in marvellous powers of expressing their thoughts, tumultuous and conflicting emotions in words or music. In verse or in symphony, or in the characters which they describe, they live and move and have their being.

They may be able only to work with headlong energy in fits and starts like Wagner, and are speedily exhausted by emotional excitement and forced industry.

Take from them their enthusiasm, zeal, and impulse to produce work, and their genius will be fruitless.

All the faults of character named may render the precocious child notorious in after life, but without genius they will not make him famous.

Emotional precocity without genius is likely to end in physical and mental prostration, unless it can be curbed and guided in early life.

Precocious Vanity and Ambition

CHATTERTON confessed that nineteen-twentieths of him was vanity and pride, which being thwarted made him take his life.

The most striking example, to me, of genius commanding recognition by pertinacious self-assertion is that of HANS CHRISTIAN ANDERSEN.

As a little boy he drew a castle on his slate and said to one of his companions: "You shall be my dairymaid there when I am a gentleman," and went on to explain that he was really of noble birth, but that the fairies had changed him in his cradle, to which the prosaic little maid replied, "Hans is mad like his grandfather." He flatly declined to go to school, because the mistress threatened to birch him, which he regarded as an intolerable affront to his dignity, and almost as an act of sacrilege.

At fourteen he sought his fortune at Copenhagen absolutely uneducated and almost penniless. Here we see him forcing his way into the boudoir of the Queen of the Ballet, the breakfast-room of a retired admiral of literary tastes, the sanctum of Thiele the collector of 'Danish Folk Tales,' the dining-room of the Director of the Royal Musical Conservatoire, behaving more or less like a lunatic, reciting his crude and illiterate compositions and clamoring for immediate recognition and assistance, which he got by dint of most amazing pushfulness and impudence.

"You have to go through a frightful lot of hardship first," he said to his mother, "and then you become famous." Rebuffs were but as water on this "Ugly Duckling's" back. Modesty was a quality unknown to him as fear to Nelson.

The vanity of a spoilt imperious child marked him from babyhood to death, and but for this his genius might have flickered out unknown to us.

Another instance of vanity insisting on recognition of its sources is that of GEORGE CRABBE (1754–1832), the East Anglian poet, who intruded on Burke and rated him on his duty towards struggling men of genius.

TASSO's vanity was so overfed by praise and honour in his early life that he owns "he could not live in a city where all the nobility did not either yield him first place, or at least content themselves with a perfect equality in all exterior marks of honour." (Terman, *vide* Ireland, Alienist and Neurologist, 1891.)

Pride, vanity, ambition and self-assertion may bring genius to the fore. Without them the ablest may remain in obscurity; whilst they may be the ruin of those whose nature is hypersensitive to slights and need encouragement for every effort made.

Precocity in Introspection and Self-consciousness

It is said that anyone can write a good book about himself or herself. Certainly some of the greatest studies of human character and records of life have been mainly autobiographical, and some systems of mental and moral philosophy have been largely based on self-analysis.

Precocious self-consciousness and introspection may in neurotic subjects lead to all that is morbid; to hypochondriasis and melancholia; to overweening pride, ambition, and vanity; to cowardice, cunning, and desire to overreach all others; in short, to egoism of the most offensive kind—and failure. On the other hand, these features have been predominant in many whose genius is undoubted.

The autobiographies of Cellini, Jerome Cardan, Rousseau, Marie Bashkirtseff and Berlioz, illustrate their characters.

CELLINI revealed his egoism with most extraordinary and naive effrontery. He was absolutely divested of moral sense.

JEROME CARDAN's autobiography is that of a neurasthenic egoist from end to end. He flayed himself deliberately, proclaimed aloud his many sins and vices, yet took the greatest pains to show how great he was in spite of them.

ROUSSEAU's confessions are those of an egoist, naked and unashamed—a child of nature devoid of any kind of modest reticence, absolutely self-centred.

MARIE BASHKIRTSEFF's diary contains an incoherent jumble of keenly felt fleeting emotions, and white-hot passions—illogical, unreasonable and absurd. She regarded herself as the most important item in the universe. She has inspired a school of imitators, who publish diaries all about themselves. It is only charitable to conclude that most of her ravings were due to phthisical pyrexia.

BERLIOZ as a boy of twelve describes his hysterical transports of passion for his youthful Estelle with the utmost *abandon* and without the slightest sense of loss of dignity.

Such frenzied neurasthenics were only saved from failure by the peremptory demands of genius for production.

Without genius, those who are but seething bundles of emotions bear no fruit. They develop every form of hysteria and neurasthenia. They spend their lives in seeking patent cures for exhaustion bred by passion, and shriek and rail against an inappreciative world. They sometimes end in monomania or perhaps in lunacy or suicide—or they swell the roll of cranks and faddists who burn to reform something and to punish somebody, and usually end in extinguishing themselves.

Precocious egoism, and not precocious intellect foretells their fate.

Genius Irrepressible

I need not enlarge further on the struggles against ill-health, poverty, and want of education; the innumerable privations, disappointments, affronts, slights and inappreciation by the world, which many a genius has had to meet.

Sometimes a helping hand has been given just in the nick of time, for there are many who like to find Swans.

More frequently, genius has fought its way unaided, and over-stepped all barriers.

NEWTON'S MSS. were destroyed by the carelessness of his dog Diamond.

AUDUBON'S two hundred pictures of birds, the work of years, were eaten by rats.

PALISSY'S potteries and wares were destroyed over and over again, and he was left starving and homeless.

CARLYLE'S first volume of the French Revolution was burnt by a housemaid.

The ordinary man would be crushed for ever by such incidents, which, in the case of genius, only excite to renewed efforts.

DARWIN said, when one of his manuscripts was lost, "I have a copy, or the loss would have killed me." Yet one cannot doubt that like his confrères he would have set to work to write it out again.

Although I was brought up on copybook maxims, I still believe them true. It may still be said that genius is irrepressible and triumphs over every obstacle. A Handel will always find a spinet in a garret; a Wilkie or a Canova his pencil; a Newton or a Ferguson, his tools.

An ardent thirst for learning always meets a well in which to quench it. Balzac's ill-treatment could not destroy the creations of his genius—cold and starvation could not make him sterile.

A Harrow master said of Sir William Groves, the scholar, "So active is his mind that even if left naked and friendless on Salisbury Plain, he would, nevertheless, find his way to fame and fortune"—and this applies to genius in large. It asserts itself in spite of any let or hindrance.

A Wagner's life may be one long-drawn wail of neurasthenic misery. A Darwin may be incapable through illness of working more than an hour or so at a time. Yet their creations are bound to see the light, although their travail may be one of sorrow and keen anguish.

The essence of genius is that it is creative. Desire for production is of the mind and of the body. Each clamours for obedience, and in certain natures each must be obeyed.

On the other hand, there are many who may have the intellect and the precocity of genius without its enthusiasm, zeal, and impulse to create, and these are found to rank amongst life's failures.

Some of undoubted ability share with genius its ambition and desire for production without its mastery of detail—whether in art or literature—and are prostrated by bitterness and chagrin when critics, publishers and reviewers prove unkind.

All these failures may be considered under the heading, "*Psychasthenic Precocity*."

Psychasthenic Precocity

To many the conception of a precocious child is merely a picture of a small, restless, pert and witty being, full of whims and fancies—garrulous, exacting and peevish, depressed and lethargic by day, restless and excited by night. A spoilt, pampered and petted creature whose shrewd sayings are repeated with admiration before his face, and whose little tricks, of recitation, singing, etc., are paraded for the delectation of all and sundry, who regard him secretly as an unmitigated nuisance.

Types of this kind are always thin, and supposed to be threatened with consumption or heart disease. They are subject to night terrors, "habit spasms" and various antics and meaningless gestures. They are frequently prostrated by attacks of cyclical vomiting and headaches, or of entero-spasm, attributed to appendicitis. Cyclical albuminuria is common in them, and fears of Bright's disease are, therefore, entertained with consequent elaborate treatment. Palpitation, flushes, sweats and pallor, urticarial eruptions, spasmodic asthma, vasomotor disturbances, nervous dyspepsia, irregularity of the bowels, are common.

Truper ("Minor Mental Abnormalities in Children," *Child Study Monthly*, 1898) says (in substance) of the nervously excitable type of morbid precocity, that "there is no lack of apparently precocious intelligence; it is not real, however, but due only to a fantastic and excitable imagination."

Children of this type interrupt with all sorts of wise questions. They are restless as butterflies, peevish and stubborn. They are likely to show volitional defects. Commonly they are well gifted in language, and in general interested in words rather than things.[1] Their weakness only comes to light when they are overloaded with subject matter of instruction.

The matter is complicated by the foolish pride of parents. Worst of all, the teacher accepts their qualities as symptoms of genius in language, philosophy, etc., and is likely to encourage the pupil to continue his interest in book knowledge and general instruction rather than adopt the far more sane method of restoring balance by the study of concrete things and by feeding the sense of reality.

Meyer (*Amer. J. of Psychology*, October, 1903) speaks of the morbidly precocious as being "prematurely and one-sidedly conscientious" and often of exalted religious and moral standards, and having a *furor* for abstract matters. They shun companions of their own age, and cling to those who are older and can better feed their insatiable curiosity. They are irritable, erratic, whimsical and hypersensitive. . . . They are egotistical, subject to fantastic day-dreaming, and become too good for the world. They take more interest in words, books and remote philosophical matters than in actual experience. (Quoted from *Lewisham Terman.*)

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[1] It is interesting to note that some of *Shakespeare's children* showed their precocity in aping their elders by playing on the different senses of words. Thus we find the little prating Duke of York bandying words with Gloster when he begs the dagger from him. (*Richard III*, Act III, Sc. 1) :—

Glo. A greater gift than that I'll give my cousin.
York. A greater gift ! O that's the sword to it.
Glo. Ay gentle cousin, were it light enough.
York. O, then, I see you'll part but with light gifts ;
In weightier things you'll say a beggar nay.
Glo. It is too weighty for your grace to wear.
York. I weigh it lightly, were it heavier.
Glo. What, would you have my weapon, little Lord ?
York. I would, that I might thank you as you call me.
Glo. How ?
York. Little.

Again, Moth to Armado in *Love's Labour's Lost* (Act I, Sc. 2) :—

Moth. How mean you, sir ? I pretty, and my saying apt ? or
I apt, and my saying pretty ?
Arm. Thou pretty, because little.
Moth. Little pretty, because little. Wherefore apt ?

It is obvious that all these characteristics may be shared alike by the budding genius and by the intellectual ne'er-do-well. The problem will always be—how to deal effectively with each.

Galton says, "A youth of ability and genius is almost independent of ordinary school education. He is omnivorous of intellectual work. The best care a teacher can take of him is to leave him alone, just directing a little here and there and checking desultory tendencies."

Consideration of the many instances in which genius has shown itself intolerant of routine will lead us to endorse his views—so far as genius of the purely intellectual order is concerned.

The *Intellectus Universalis* can rarely be exhausted by its own vitality.

Genius with its mainstays—steadfastness of purpose, zeal, self-reliance, ambition and impulse to create, may safely be left to itself. But the psychasthenic emotional type which is usually not only bereft of these qualities, but is swayed by timidity, self-consciousness, despondency, and dislike for any kind of mental or physical drudgery, and is often accompanied by egoism, vanity and hypersensitiveness needs special consideration.

Precocious children of the psychasthenic type are as a rule unfitted for the ordinary routine of school life. They cannot adapt themselves to their surroundings. They require individual attention which cannot be supplied in public institutions.

I do not agree with Trüper that their intelligence is apparent, not real. Their intellectual powers are often high, and by judicious management and encouragement may be fostered.

Attempts made to enforce industry in uncongenial tasks, to cram the memory with elusive facts, to excite ambition by blame, and fear by prophecy of failure, may result in mental and physical breakdown.

Their education should follow the lines for which they show most aptitude. Their reading should be guided, not forced. General information should be absorbed by degrees, not rubbed in *en masse.*

As previously stated, a good memory is essential to eminence, and probably all truly great men possess it.

Yet memory is of different kinds, visual, auditory and associative. Some are extremely receptive of abstract ideas and theories, but cannot retain concrete facts, others retain the facts but cannot reason from them.

The obviously clever child who yet finds difficulty in assimilating arbitrary facts may be pressed and urged to do so until his mind is bankrupt; and then his precocity bears the blame.

On the other hand, the glib fact reciter may be successful in examination and regarded as brilliant, but belies his precocity by failing in after life.

Psychasthenic precocious children should be spared all exaggerated and one-sided teaching on religious, moral, and social questions. Their opinions on all such subjects are sure to be lacking in breadth of view, and are apt to become morbid obsessions.

Their moral fibre may be strengthened by sympathy and consideration. A word of praise and encouragement often does more good than torrents of blame.

Above all, they need a simple, healthy, open-air life. Freedom from artificial emotional stress is essential, but it should not be forgotten that boredom and ennui are as productive of neurasthenia and morbid mental states as a life of constant restlessness and social excitement.

I shall not indulge in the customary Jeremiads on the faults of modern methods of education in general.

All systems have their advocates. The claims of liberal *v.* utilitarian education, formal *v.* subject-matter studies, grammar *v.* no grammar, scientific *v.*

literary training have all been extolled in turn and hotly contested.

They are as far from being settled now as they were in the Middle Ages, because minds differ and no system is adapted for all alike, though each may be suitable for some. Any system which does not allow for individuality of mind, tastes, and character, may be harmful.

It is certain that children of mediocre ability as well as those of the psychasthenic type of precocity may suffer from mental strain in consequence of overpressure.

Clever children who possess strong nervous endowment can accumulate knowledge with impunity. It is the psychasthenic variety which is most frequently brought to naught.

Psychasthenics may be so innately, they are frequently the offspring and descendants of neurotic parents and ancestors: they may develop neurosis in consequence of delicacy and illness, or of emotional strain and mismanagement.

If parents would only learn that brightness and ability are not unfavourable or morbid signs unless associated with nervous instability and hyperasthesia; and if teachers would refrain from forcing on bright, clever, but neurotic children who show signs of impending mental exhaustion, which is easily recognized and may be counteracted if taken in time, the term Precocity would lose much of its evil significance.

The precocious child is not necessarily a genius, but by careful management he may, at least, be prevented from becoming a failure.

II

THE HISTORY OF NEUROLOGY

THE HISTORY OF NEUROLOGY

In considering the History of Neurology, and, indeed, the History of Medicine in general, one is constantly reminded of a famous dictum of Auguste Comte, which is: "The older the World grows, the more the living are indebted to the dead."

Virchow, again, has said rather bitterly: "It is probably justifiable to recognize historic rights, for, in fact, it is astonishing with what heedlessness those who prize as a discovery every trifle which they have themselves found out, condemn the results of their predecessors."

Some would say: "Pereant qui ante nos nostra dixerunt." Others may dismiss all our ancient forefathers' knowledge with the contemptuous comment: "Antiquitas sæculi, juventus mundi."

Yet the scientific youth of the world saw facts, although its deductions from them might be often wrong. The facts recorded were frequently forgotten or ignored; then re-observed in later ages and hailed as startling novelties. New names revive dead doctrines—"Multa renascuntur quae jam cecidere."

Therefore some of us may be led charitably to credit our ancestors with greater knowledge and foresight than they had. Their glimpses of discoveries may seem to merit the distinction of making them. Often they were very near the mark, yet it is true that facts and inferences which seem obvious to-day eluded them. Blinded by prejudice and allegiance to authority they sometimes failed to grasp knowledge which, like Justice in Plato's model state, " lay rolling at their feet."

It is necessary to avoid either extreme, and to dwell merely on the facts which were known and the views which were held in ancient times without exaggerating their number and importance.

Yet, indeed, their number and importance were great; so great that the mere enumeration of them could amply fill the time at my disposal.

And so I cannot indulge in reflections on the human interest which is attached to the lives, thoughts, characters and surroundings of the founders of Neurology; I can but put before you a narrative which I know is " bald," but I trust not " unconvincing."

Division of Medical History into Periods

The periods into which the history of medicine, so far as that of Neurology is concerned, may for convenience be divided, are :—

1. The period of Greek and Roman influence from the time of Hippocrates, fifth century B.C., to the downfall of the Western Empire in A.D. 476.
2. From the fall of the Western Empire to the end of the fifteenth century, including the Arabian ascendancy (eighth to thirteenth century), the Middle Ages, and the dawn and rise of the Renaissance.
3. Medicine from the sixteenth to the end of the first quarter of the nineteenth century.

I can only deal with these periods in so far as the history of Neurology is concerned, mentioning those individuals alone who seem to have aided most in the evolution of Neurology, which is essentially a science of modern times.

I must pass quickly over the pre-Galenic period.

HIPPOCRATES (B.C. 460–377 or 370), regarded the

Brain as the seat of the intelligence. By it, he said, we think, understand, see and hear, know what is base and honourable, good and evil, pleasant and unpleasant. It is the chief organ in man.[1]

The Brain acted as messenger and instrument of the intellect.[2] It was also like a gland condensing into Mucus, vapours which arose to it. Humour flowed through the nose from it, and if free and unobstructed purified the Brain itself,[3] but if restrained and obstructed, became acrid and corrosive, and produced much disturbance of the system and derangement of the mind.

He thus denied that the heart was the seat of intelligence though in the book *De Corde* attributed to him the mind is placed in the left ventricle.

Γνὼμη γαρ ἡ τοῦ ἀνθρώπου πέφυκεν ἐν τῇ λαιῇ κοίλιῃ (*De Corde*, p. 51).

The book *De Corde* is, therefore, probably spurious. (T. Cooke, *Treatise on Nervous Diseases*, 1820, p. 4.)

Hippocrates knew little or nothing about nerves, which he confounds with veins, ligaments and tendons.

He believed, however, that nervous power was conveyed by the veins, for if the spirit which flows through them be stopped by pressure, for instance, in sitting or lying down, the part supplied became powerless (*'Ακρατὲς γίνεται*).

A. Hirsch (*De Collectione Hippocraticae Auctorum Anatome*, p. 26) shows how imperfectly the brain and spinal cord were understood by the school of Hippocrates. The Brain is merely described as double, divided centrally by the membranes, of which the upper is hard and the lower soft and intimately applied to the brain; only the membranes of the cord are described and not the cord itself.

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[1] *Κατὰ ταῦτα νομίζω τὸν εγκεφάλον δύναμιν πλείστην ἔχειν ἐν τῷ ἄνθρωπῳ* (*Lib. de Morb. Sacr.*, p. 354).

[2] *'Es δὲ τὴν σύνεσιν ὁ ἐγκεφαλός ἔστιν ὁ διαγγέλων* (*Lib. de Morb. Sacr.*, p. 354).

[3] 'Εγκεφαλου λύματὰ (*de Gland.* p. 53).

A more complete account is said to be in another part, but it is not to be found in any of the Hippocratic writings which have come down to us.

The term Νεῦρον is applied to both tendons and ligaments, but occasionally the word Τονοὶ is found and may be held to mean nerves, though no clear account of the latter is given, but he seems to be responsible for the notion that nerves are hollow for the conveyance of " animal spirit."

Hyrtl and Sprengel quote passages in which Hippocrates (Sprengel, *Pragmatische Geschichte der Arzneikunde*, Tom. I, p. 4) described the cranial bones, their sutures and also the spinal vertebræ and their curves (Περί ἀγμῶν καὶ περί ἄρθρων) (Hyrtl, *Antiquitates Anatomicae rariores*, p. 87).

This meagre account of Hippocrates the Great only includes his main contributions to Neurology. As a clinical physician he carefully observed and described Apoplexy and its resultant forms of paralysis. He knew that injury to one side of the brain produced paralysis or convulsions on the opposite side of the body. He described diphtheritic paralysis. He took the half-contemptuous, half-tolerant attitude towards Hysteria which has been adopted by physicians throughout all ages. All hysterical symptoms were due to determination of menstrual blood to the heart and diaphragm. They were cured by re-establishment of the Catamenia or by pregnancy, and when this happened, he said these women present their jewels and best clothes to Diana at the bidding of some priest. " But," he added, " I advise them to get married as fast as they can " (*De Puellis*).

Hippocrates also described Phrenitis, Febrile Delirium, Mania, Melancholia, Dementia and Paranoia.

He was, of course, well acquainted with all the phenomena of Epilepsy, and he ridiculed the idea that Epilepsy was of Divine origin as indicated by its synonym, Morbus Sacer. He said he could point out many disorders not less wonderful in their symptoms, to which no one ever thought of applying the term "sacred." If they are of Divine nature, he added, they ought to be cured in the Temples, but are not (Hip., *De Morb. Sacr*, p. 1).

Hippocrates is said to have used the word "Enormon," which Hermann Boerhaave, in 1745, translated "Impetum faciens" as the equivalent of what we should now call "nervous energy" or force.

Plato (B.C. 427–347), in the *Phaedo* discussed whether we have intelligence and sense through the blood or by air or fire, or whether the sense of hearing, seeing, and smelling depend upon the brain.

Καὶ πότερον τὸ ἆιμα ἐστίν ᾧ φρονοῦμεν ἢ ὁ ἀὴρ ἢ τὸ πῦρ (*Phaedo*, p. 96).

He decided that the brain was the seat of intelligence and perception and was the governing principle of all.

The passionate element including anger and courage he placed in the heart, the lower appetites in the liver, whilst the semen was furnished by the brain.

Plato thus distinguished between purely intellectual phenomena and those more nearly associated with physical life.

He did not recognize nerves in the modern sense. "*Νεῦρα*" to him meant ligaments, and he used the term *Νευρώδης* to apply to membranous structures in general.

Plato did not give any description of the brain, and he did not distinguish between the spinal cord and the marrow in bones, an error corrected by Aristotle.

NOTE ON PLATO

Plato was a philosopher, not a physician. He had a low opinion of physicians, even hinting that Hippocrates and reason if brought together might not agree. The fact that they accepted fees put them on the inferior level of Sophists. The best physicians he held to be those who had most experience of disease in their own persons, and were therefore hardly to be considered robust. But as Plato saw no use in keeping sickly people alive, he would naturally regard doctors as unnecessary encumbrances on the State.

His influence on the progress of medicine was unfortunate, for there came a time when, revived under the name of New Platonism, a belief in demons, sorcery and witchcraft prevailed in the mystic treatment of the sick.

Aristotle (384–21 B.C.), regarded the brain merely as an organ for cooling the heat and fervour of the heart. It was composed of earth and water, and was cold, dry, and bloodless, for the vessels only supplied blood to the meninges, two of which he recognized. He knew of the cerebral ventricles and the cranial bones, which he called *βρίγμα, κορυφή* and *'Ινίον*. The heart was first formed in animals (he had observed the " punctum saliens " in the chick), life, perception and sensation resided in the heart, though he added that some thought they are situated in the brain, which he denied on account of its assumed bloodlessness. Like Plato he confused nerves with ligaments, but several times he uses the words, *Πόροι τού 'εγκέφαλου*, which Sprengel and others have held to signify nerves.

Philippsohn,[1] however, thinks that by the *Πόροι* or channels which run to the eye, Aristotle meant not the optic nerves, but vessels. The same term (which means channels) is applied to the meatus auditorius, the œsophagus, trachea, tubuli seminiferi, urethra and lactic ducts.

As a matter of fact the existence of optic nerves in all animals was doubted long after Aristotle's time. On the other hand, as Falk and Sprengel have suggested,

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[1] Ὕλη ἀνθρώπινη (*Anatomie des Plato und des Aristoteles*).

Aristotle's term *Πόροι των ἀισθητήριών*, may signify the nerves of sensation.

However, he thought that nerves originated in the heart, and it is quite as likely that he was really referring to blood-vessels.[1]

He described the auditory nerve as a "vessel."

Aristotle, through the munificence of Alexander, was supplied with every means and opportunity for laboratory research. His anatomical drawings have disappeared, but judging from one crude specimen illustrating an account of the nervous system in a MS. of about the year 1152, which is evidently based on his teaching and that of Galen, we have not suffered great loss.

This MS. is now Ashmole 399 in the Bodleian Library, and the illustration has been reproduced by Sir Victor Horsley in his Fullerian Lectures for 1891.

HEROPHILUS AND ERASISTRATUS (*circa* B.C. 335–280.)

Herophilus and Erasistratus were contemporaries, Herophilus being the senior. They owed their opportunities for scientific investigation to the liberality of Ptolemy I of Alexandria, who founded the famous library, museum and laboratory in that city.

HEROPHILUS was the first to describe and distinguish cerebrum from cerebellum, the junction of sinuses which still bear the name "Torcular Herophili," the fourth ventricle with its Calamus scriptorius, where he placed the seat of the soul; and also the choroid or plexus retiformis[2] to which Galen afterwards attached so much importance. He was the first to speak of peripheral nerves, to divide them into motor and sensory, and to distinguish between those of cerebral and spinal origin.

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[1] He mistook the Chordæ Tendineæ for Nerves, and seems to have regarded the cardiac vessels as continuations of the same throughout the body.

[2] *τό δικτυοειδὲς πλέγμα.*

Erasistratus also distinguished between sensory and motor nerves. Rufus of Ephesus states that at first Erasistratus thought all nerves proceeded from the meninges, but later that motor nerves only did so, whilst sensory nerves sprang from the substance of the brain. (Sprengel, *op. cit.* 1, p. 542.)

Erasistratus described with considerable accuracy the structure, convolutions and ventricles of the brain. He regarded the convolutions of the cerebrum and still more those of the cerebellum as the seat of thought, and located mental diseases in the brain.

Paralysis was due to an aberration of the moisture which nourishes motor nerves. (Baas, *History of Medicine*, p. 122.)

He taught that air, inhaled, underwent some kind of elaboration in the lungs, whence it passed to the heart, where it again became changed; from the heart it travelled to the brain, where in the ventricles it became converted into *Animal Spirit* which was the source or cause of mental and nervous action, a doctrine which prevailed for about 1500 years after his time.

In a way it was an important advance, for it represents, as Victor Horsley says, "the first glimmerings of the truth that what we call mental phenomena are the concomitants, if not the result, of the functional activity of the brain and spinal cord, and is also the first attempt to refer those phenomena to their undoubted source." (*Structure and Functions of the Nervous System*, p. 7.) At the same time the invention of the term "*Animal Spirit*" to explain the phenomena of nervous energy led to endless absurdities as regards the physiology and psychology of the nervous system. *Πνεῦμα ψυκικον*, at first used in the singular to designate an immaterial and hypothetical abstraction, gradually became employed in the plural—"*Animal Spirits*." By degrees the animal spirits acquired material attributes, were spoken of as fluids or even as though they were personalities like imps and sprites, and this gave rise to many misconceptions.

Erasistratus, like Herophilus and indeed all the early writers, including Galen, confused nerves with ligaments, tendons and even blood-vessels; for he speaks of them as hollow canals filled with blood during life.

Erasistratus and Herophilus according to Celsus, were permitted to dissect the bodies of criminals even when living (*etiam spiritu remanente*) "that they might see those things which Nature had hitherto concealed; that they might view the position, colour, figure, and magnitude of parts, their order, hardness, softness, etc." (Celsus, *Med. Præf.*, p. 7.)

He inveighed against the cruelty of the proceeding though enlarging on the importance of *dissectio cadaveris*.[1]

It is impossible to determine how far this accusation against Herophilus was true. Dr. J. Finlayson (*Glasgow Med. J.*, May, 1893) considered that Galen's silence on the point is evidence against the existence of such a practice.

In the "Theriase," however, there is a reference to the subject. Here, dangerous experiments by poisons and such-like on human beings are condemned except in the case of criminals sentenced to death by the authorities (XII, 252). The authenticity of the Books De Theriase is doubtful, as they are not mentioned in Galen's Book on his Books. Certainly Galen never referred to actual vivisection of human beings in the sense implied by Celsus and Tertullian, and as he himself could only experiment upon animals one might expect to find allusions in his works to the alleged observations made by Herophilus on men, especially as he frequently refers to the works of both Herophilus and Erasistratus.

For further discussion of this unpleasant subject, cf. Greenhill on Marx's Herophilus, *British and Foreign Med. Review*, Vol. XV, 1843, p. 109, footnote.

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[1] "Incidere autem vivorum corpora, et crudele et super vacuum est: mortuorum discentibus necessarium" (Lib. I, *Proœm*).

One prefers to believe that Herophilus and Erasistratus were merely present at executions and perhaps secured for the unfortunate criminals a less painful mode of death than otherwise would have been their lot.

Tertullian's spiteful and rancorous tirade against Herophilus was probably inspired less by pity for the supposed victims than by hatred for men of science, whom he would reserve for far greater tortures in Hell than they could inflict on earth.

He refers to Herophilus as "that Physician or Butcher ('aut Lanius') who dissected 600 persons in order that he might scrutinize nature: who hated men in order that he might gain knowledge." (*De Anima*, Cap. X.)

Tertullian's own love of mankind may be estimated by the savage sermon in which he proposed as a counter-attraction to visiting the theatres and spectacles, the promised joy of watching the enemies of Christ writhing amid the torments of Hell.

"How shall I wonder? How shall I laugh? How shall I rejoice? How shall I triumph when I behold so many and such illustrious Kings, who are said to have mounted into Heaven groaning, with Jupiter their God in the lowest darkness of Hell!

"Then shall the soldiers who had persecuted the name of Christ burn in more cruel fire than any they had kindled for the Saints. . . .

"Then shall the tragedians pour forth in their own misfortune more piteous cries than those with which they had made the theatre to resound, while the comedian's powers shall be better seen as he becomes more flexible by the heat," etc.

(Lecky, *The Rise and Influence of Rationalism in Europe*, Fourth Edition, 1870, Vol. I, p. 324.)

Of other pre-Galenian writers—ASCLEPIADES of

Prusa (B.C. 128–56), confounded nerves with ligaments. Rufus of Ephesus, about A.D. 56, spoke of motor and sensory nerves both having origin in the brain, but also calls ligaments Νεῦρα.

Celsus (B.C. 30–25 to A.D. 45–50), described the skull as supported on the neck by powerful *Nervi*, but adds that the word corresponds to the Greek Τένοντες.

Nerves with him meant any kind of tendon, ligament or membrane. In speaking of "Dolor" and "Tremor" nervorum he probably alluded to muscles and tendons.

Aretaeus of Cappadocia, A.D. 30–90, employs Τένοντες[1] to mean tendons, but Νεῦρα is used either in the sense of nerves, ligaments or any serous membrane, for instance, the pleura or bladder.

Arthritis, he said, or *Ischias*, begins in the Νεῦρα or joint ligaments but later attacks all the Νεῦρα of the body.[2]

In speaking of *Tetanus* he says it gives all the Νεῦρα a hard stretched appearance, evidently meaning muscles or tendons. In the delirium of fever he says the Νεῦρα are painful and twitch.

In *Satyriasis* he says there is spasm of all the Νεῦρα and stretching of the tendons (ἔντασις Τενόντων) which may be relieved by procuring a long sleep which causes stupefaction or relaxation of the Νεῦρα (Νάρκη νεῦρων).

Certain nerves, he said, may be injured and paralysed by pressure produced by lying on a hard bed ("Ὀξεων νοῦσων θεραπευτ. Βιβ. ά. κεφ. ά).

The explanation that pain in pneumonia only occurs when the pleura is affected because the Νεῦρα of the lung are only small and incomplete as compared with those of the pleura, makes it clear that here at all events he uses the term in the modern sense.

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[1] Πέρι ἄιπων καὶ σημείων ὀξεων παθῶν (Kühn). Βιβ′. Β′. κεφ. β′ (pp. 65 58). Also, "Ὀξεων νοῦσων θεραπευτικόν Βιβ. ά. κεφ. ς′ (p 220).

[2] Page 168.

Yet Aretaeus undoubtedly distinguished between motor and sensory nerves and recognized that they may be mixed.

Anæsthesia, he said, was wont to follow injury of certain of the cranial nerves, but sometimes it was accompanied by slight motor paralysis as well.

His most remarkable contribution to neurology, however, is contained in the famous chapter on paralysis. (*Causes and Symptoms of Chronic Diseases*, Book I, ch. VII.)

Here he states definitely that when paralysis is the result of injury to the brain, it occurs on the opposite side to that injured, for the nerves after leaving their origin cross each other in the form of the letter X, whereas when the injury is below the head, as for instance in the membranes of the spinal cord, the paralysis is on the same side as the lesion.

The site of this decussation and also its existence were doubted even in the early part of the last century.

In the same chapter he describes paralysis with rigidity either flexor or extensor in character, mentions contraction and dilatation of the pupils in association with paralysis. He speaks also of paralysis of the bladder and rectum.

In his account of facial paralysis he mentions that it is often difficult to tell which is the affected side unless the patient tries to wink, laugh or speak. He did not observe the refinement between the symptoms of supra and infra-nuclear facial paralysis. It is curious that he should say that the sense of touch is lost in facial paralysis, but he also observes that paralysis of cranial nerves does not readily induce loss of sensibility. Under the term Cynic facial spasm he seems to confuse spasmodic Tic with facial and also with bulbar paralysis.

Aretaeus also was acquainted with diphtheritic paralysis (*ulcera Syriaca*) in which he distinguished an anæsthetic, a motor and a mixed form (Baas); a discovery, centuries later, attributed to Fothergill.

Note on Decussation of the Motor Tract

The fact that injuries to the brain cause paralysis of the opposite side must have been known long before Aretaeus drew attention to it. In days when broken heads were common and battles were mostly hand-to-hand combats, the sequence of events must often have been observed. Indeed, it was known to Plutarch, as Sir Norman Moore has mentioned. (Cf. Plutarch *Conjugalia Præcepta*, 20 E.)

What is more extraordinary is that the explanation given by Aretaeus, namely, that there must be decussation of the motor tracts, was not accepted even in the early part of the 19th century.

GALEN

Hippocrates, Plato, Aristotle, Herophilus, Erasistratus and Aretaeus are merely names to us. We only know them by their works. The scanty details of their lives which we possess can hardly make them live to us.

With Galen it is different. His writings tell us something of the man himself, apart from their intrinsic value.

Galen was born in Pergamos in the year A.D. 131. His father, Nicon, was a distinguished architect, geometer and savant. His mother was a scold. Galen enjoyed a liberal education. Plato was his idol from boyhood, and Platonic influence is traceable throughout his works. He had no respect for medical men untrained in "Literis Humanioribus," "who took to medicine before they could read and write or reason."

He began his medical career at seventeen, because his father dreamed that he was destined for it.

Satyrus taught him anatomy and won his heart by his knowledge of Hippocrates, though Galen himself was hardly Hippocratic in his methods.

He studied at Smyrna, Corinth, and Alexandria, and finally settled in practice at his native town of Pergamos. Here he was appointed surgeon to the gladiators.

At the age of thirty he came to Rome, and in five years' time had made his mark both as a public demonstrator of anatomy and as a fashionable physician. He seems to have found his life at Rome irksome; perhaps the constant wranglings and disputes with his colleagues ceased to amuse him, or perhaps he merely desired leisure to write his books, for he escaped from Rome in A.D. 168 in his thirty-seventh year, and after visiting Campania and Corcyra, established himself once more at home at Pergamos. Ilberg believes that his flight from Rome was really due to fear of the Plague, which was then becoming prevalent. A year later an Imperial summons from Marcus Aurelius, who was on the point of invading Germany and wished Galen to accompany him, called him back to Rome. Galen begged to be left behind, pleading his greater usefulness at home. Aurelius yielded, and departed, having first consigned the youthful Commodus to Galen's charge.

He appears to have lived in Rome, or in its neighbourhood, for he mentions a fire at the Temple of Vesta by which he suffered losses, and this occurred during the reign of Commodus, who was murdered A.D. 192. Also he refers to discussions amongst the various medical sects in the reign of Pertinax, who was assassinated in A.D. 193.

But beyond a few allusions to journeys to Lemnos to observe the manufacture of the famous Lemnian seals, and to the Dead Sea, Palestine and Crete, Alexandria and Pergamos, no further details of his life are extant. He is supposed to have died either in A.D. 201 or 210.

Galen was a most prolific writer, but careless or profusely generous in disposing of his works.

He complained that many of his writings were purloined, mangled, or published in an imperfect form by unscrupulous persons as their own.

Spurious editions of his works were common, and he was compelled to write a book about his own writings in order to protect himself.

Bibliography of Galen

According to Baas, in addition to works on Philosophical, Grammatical, Mathematical and Legal subjects attributed to Galen, 125 in number, the Medical treatises still extant under his name are as follows :—

Genuine	83
Doubtful	19
Spurious	45
Fragments	19
Commentaries on Hippocrates	15
Still unprinted	80

The most complete edition of Galen's works is that of Kühn in twenty-two volumes.

Baas regarded as the most important treatises by Galen :—

De Usu Partium Corporis Humani.
De Motu Musculorum.
De Locis Affectis.
De Differentiis Morborum.
De Pulsibus.
Ars Parva.
De Ratione Medendi.
Methodus Medendi.

De Crisibus.
De Differentiis Febrium.
De Sanitate Tuenda.
De Compositione Medicamentorum.
De Morborum Causis.

In comparison with Hippocrates, who occupies seven pages in Choulant's *Bibliotheca Medico-Historica* (Lips., 1842) and on whom upwards of one hundred monographs have been written, Galen has been neglected.

Before 1842 only nineteen publications concerning Galen's works existed, and these were ancient and difficult to procure.

Daremberg in 1848 published—1. *Fragments du Commentaire de Galien sur le Timée de Platon* (in which Galen is considered as a Philosopher).

2. *Traductions des Œuvres Anatomiques, Physiologiques et Médicales de Galien* (2 Vols.).

3. *Expositions des Connaissances de Galien sur l'Anatomie et la Physiologie du Système Nerveux.* (Paris, 1841.)

In 1854 Von Pass of Berlin published a short summary of Galen's teaching, *Claudii Galeni vita ejusque de Medicina merita et scripta* (66 pages).

In 1871 Friedrich Falk wrote an essay, entitled, *Galen's Lehre vom Gesunden und Kranken Nerven Systeme* (Leipzig, von Veit und Comp.), to which I am largely indebted.

In 1891 a posthumous essay on Galen from the pen of the late Henry J. Tylden, a member of this College, was printed privately for his friends.

Henry Tylden was a brilliant scholar, and had evidently made a profound study of Galen's works, and in his charmingly written brochure I have gathered some of the details mentioned above.

Dr. J. Kidd, in his *Cursory Analysis of the works of Galen so far as they relate to Anatomy and Physiology*

(*Tr. of Prov. Med. and Surg. Association*, p. 2, Vol. VI, Art. 5, p. 335), drew special attention to Galen's services to Neurology.

Other important references to Galen can be found in—

Dr. W. A. Greenhill's article, "Galenus" (Smith, *Dict. of Greek and Roman Biography*, Vol. II. London, 1870).

Laboulbène, *Histoire de Galien, sa Vie, ses Œuvres, son dernier Traducteur* (Daremberg, *Gaz. des Hôpitaux*, pp. 1041, 1188. Paris, 1882).

R. Gasquet, *The Practical Medicine of Galen and his Time* (*Brit. and Foreign Med. Chir. Rev.*, Vol. XL. London, 1867).

Puschmann, (Th.), *A History of Medical Education.* Translated by E. H. Hare, 1891.

Dr. J. F. Payne's learned and appreciative Harveian Oration for 1896 must have inspired others, as myself, with renewed interest in Galen.

The late Dr. James Finlayson included in his *Biographical Demonstrations* one on Galen in 1891. It is highly interesting, but contains no reference to Galen's views on Neurology.

Baas does not include amongst Galen's most important works his books on Anatomy, probably because until two years ago only nine of the fifteen were accessible. The remaining seven with the exception of a few fragments in the original Greek of the tenth book only existed in MS. Arabic translations.

In 1906 Max Simon published the missing books under the title:

" Sieben Bücher
Anatomie des Galen

'ΑΝΑΤΟΜΙΚΩΝ 'ΕΙΓΧΕΙΡΗΣΕΩΝ ΒΙΒΛΙΟΝ Θ̅–Ι̅Ε̅

Zum ersten Male veröffentlicht nach den Handschriften einer arabischen Übersetzung des 9 Jahrh.

N. Chr. ins Deutsch übertragen und Kommentiert, von Max Simon, Dr. Med., Leipzig, J. C. Hinrichs'sche Buchhandlung, 1906."

The world is greatly indebted to Dr. Max Simon for bringing these hidden treasures to light, and he has further enriched them by his invaluable comments on the text.

The books themselves are in the form of school demonstrations on anatomy, so graphic that one almost seems to be present at their delivery. Being Galen's latest works on Anatomy, he often epitomizes and also elaborates in them what he has said before, and in some places elucidates passages in his earlier writings which are obscure or corrupt and have occasioned disputation.

Books X, XI, XIV, XV deal specially with the Anatomy of the Nervous System. Although in parts inaccurate, his account of the Cranial nerves in general, his knowledge of their function gained by experimental division of them, are wonderfully correct, and place him far above his predecessors and contemporaries. It is no wonder that for many ages his successors thought that Wisdom must have died with him.

Galen regarded dissection as the basis of all medical research. He devoted fifteen books to the subject, and described the methods which he considered the best.

He recommended the study of the anatomy of apes as a preliminary ; he pointed out both the similarity and dissimilarity of their structure to that of human beings and mentioned the species of ape which most closely resembles man.[1]

Without such preliminary practice, he said, even such a piece of luck as finding a dead German to dissect will be valueless (S. Sprengel, *Gesch. der Arzneikunde*, I and II, 148).[1]

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[1] A tail-less ape of the order of the Macaques. Daremberg renders it "Magot," which also applies to the Cynocephalus of Aristotle (*Littré's Dictionary*).

He had the opportunity of observing the similarity, especially during an outbreak of anthrax in Pergamos, Asia Minor. In one case, the skin of the neck and superficial structures being destroyed by ulceration it was possible to study the deeper anatomy of the parts.

The Methodicists, who held the study of Anatomy to be useless, hurt the patient on this occasion and saw nothing. The pupils of Satyrus, Galen's own master, by careful and delicate manipulations were able to demonstrate to their own satisfaction the functions of muscles and the course of vessels and nerves (Tylden on Galen, p. 37). *Περί φλέβων καὶ ἀρτηρίων ἀνατομής κεφ. ξ* (ii. 803).

Osteology. Galen advocated study of the human skeleton not only from descriptions of it in books, but by actual observation. This, he said, could easily be done at Alexandria.

It seems that long after the days of Herophilus, skeletons were granted for the purpose of medical research at Alexandria, and Galen himself lost no opportunity of obtaining bones from graves or from criminals executed and left to the birds, to satisfy his zeal for osteology. But he seems never to have dissected a fresh human body.

His description of the cranial bones is fairly accurate. According to Falk, Galen leaves out the Foramen magnum in his description of the occipital bone. Falk (*op. cit.*, p. 9), therefore, considers the text to be corrupt.[2]

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[1] Galen himself met with two such instances of good fortune. Once he found a robber's corpse picked clean by the birds, and on another occasion the mouldered body of one drowned in a mountain torrent. Both were excellent subjects for Osteology but hardly for the study of Anatomy.

[2] In *De Ossibus*, Lib. V, p. 721, I, 28. Basle, 1538, however, Galen says: "Id ipsum os (occipitis) maximum omnium qui sunt in capite *Foramen* juxta primam vertebram habet."

He describes the different sutures, and the various abnormalities in them which give rise to peculiar cranial formations, for instance, the condition known as oxycephalus.

His account of the vertebræ and their ligaments, of the mechanism of the movements of the head on the spinal column is remarkably correct.

Anatomy of Nervous System

Galen gave a minute account of the meninges. He regarded them as designed to protect and support the brain and to keep its vessels together.

He drew attention to the attachment of the Dura Mater to the various bony points of the skull, and especially to its arrangement over the cribriform plate of the ethmoid, where he compared it to a straining cloth with innumerable holes, to the use of which I shall refer later.

He gave directions for demonstrating the sub-dural space by blowing it up with a tube.

He distinguished between the arachnoid, which he compared to the chorion of the Fœtus, and the Pia mater, and he described the extensions of the meninges which follow the fissures and convolutions of the brain, line the ventricles, and form the choroid plexuses.

Similarly he enumerated the coverings of the spinal cord, and mentioned the Cerebro-spinal fluid, the use of which was to allow free power of movement without pain.

The substance of the brain, he said, was white and soft, as if made out of foam, damp and warm.

It is curious that he does not distinguish between the grey and white matter of the brain or cord unless, as Daremberg suggests, the passage (iii., 638) in which he speaks of a harder part of the brain more resembling the Dura Mater and a softer interior part, implies the distinction between the cortex and white substance of the brain. (Daremberg, *Traductions des Œuvres anatomiques, physiologiques et médicales de Galien*, T. I, 542). Aristotle had held that the office of the brain was to cool the heart, the brain being the coldest part of the body.

Galen disproved this by actual experiment. He showed that on removing the skullcap and Dura mater of an animal, the brain was not cold, but warm.

This was proved also, he said, in cases of fracture of the skull, when the exposed brain could be ascertained to be warm to the touch, though it speedily became cold. This he regarded as of special importance, as chilling of the brain was the greatest danger to be anticipated in cases of fractured skull. Hence, in opposition to Hippocrates and Celsus, he used warm water and warm oil instead of cold applications to wounds which exposed the brain.

Galen divided the brain into fore and hind parts, i.e. cerebrum and cerebellum, as Herophilus and Erasistratus had already done. He distinguished the hemispheres though he does not name them as such, and their separation from each other by the membrane. The cerebellum was generally of the same colour and nature as the cerebrum, but harder in substance, and it became harder and harder until it joined with the spinal marrow, which spot was the weakest in the whole cerebro-spinal system.

He regarded the *spinal cord* as an offshoot of the brain,[1] and disputed the teaching of PRAXAGORAS and PHILOTIMUS that the brain was a thickening and prolongation of the columns of the spinal cord, as he found that the latter, especially in its hinder and lower portions that join the brain have far fewer convolutions than the brain itself.

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[1] *'Οἶον τὶ πρέμνον. ββ. ά-κεφ. ή* (iv. 541).

NOTE ON PRAXOGORAS AND PHILOTIMUS

Praxagoras and Philotimus were of the Hippocratic school (400–335).

Praxagoras held the view that the arteries contained air and not blood.

Galen proved once and for all that this was not so by ligaturing an artery in two places and showing that the intervening portion was filled with blood.

He compares the spinal cord with the stream of a spring. It was a second brain for the parts below the head. (*Περί χρείας*, XII, 15).

The spinal cord was of a similar substance to the brain, but less moist and becoming harder the lower it goes, yet always softer than the nerves. As an important distinction between brain and cord, he mentioned that the former pulsates and the latter does not.

Galen recognized the synchronous pulsation of the brain with the pulse, but noted that many attributed it to a specific faculty of the brain and of its coverings, and not as he himself did, to the pulsation of the central arteries.

For the study of brains he recommended that those of the ox should be procured from the slaughterers either with or without the skulls. Care should be taken not to injure the brain in removing it by means of chisel and knife (Tom. III, 670–683; Tom. II, 712–723).

Relation of Convolutions to Mental Faculties

Galen disputed the assertion of Erasistratus that the complicated convolutions of the brain are connected with the mental superiority of man, on the ground that in that case the ass should have a simple brain, which is not so.

Kidd, however (*Tr. of Provincial Med. and Surg.*

Association, p. 2, Vol. VI, Article 5, p. 335), draws attention to passages from which it is clear that Galen believed the difference in mental power in men to be caused by deviation in the construction of their brains, and noted that weak mental powers are generally to be found in those whose heads are too small or too big.

But Pericles, whose head was onion-shaped accord-to Plutarch, was a notable example to the contrary.[1]

The parts of the Brain described by Galen under present or other names are—

1. The Τυλώδης, or Corpus callosum, discovered on separating the hemispheres (which are not so named by Galen). On raising this, the fine canals leading to the ventricles of the brain are seen.

2. The two lateral ventricles (*ἅι προσθίαι Κοιλίαι*).

These are double, like all organs of the senses, he says, in order that their functions may continue if one is injured.

For instance, a youth at Smyrna received a wound on the right side of the head which punctured the ventricle. He recovered, but had both ventricles been injured he could not have lived a moment.

Also he stated that disease may affect one ventricle, but so long as the other remains sound, life may continue.

The inner fore part of the lateral ventricle he described as the Optic Thalamus (*Θάλαμος Νεῦρων 'οπτίκων*) (IV, 276).

3. The *third ventricle* and *fourth ventricle* were also described by Galen. The "iter" he spoke of as a canal, *Πόρος*, which united the cerebrum and cerebellum.

He was acquainted with the communication between the third and lateral ventricles.

The *Fornix* he compared with an arch stretched over the third ventricle in order to support the mass of the brain above.

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[1] Plutarch says that statues of Pericles always presented him wearing a helmet in order to disguise the peculiar formation of his skull.

Galen adds that Erasistratus had already known and described the ventricles of the brain.

The *Corpora quadrigemina* are defined as processes of the brain (ἔξοχαι) and having a similar structure. He noted their resemblance to the Nates and Testes. The similarity perhaps suggested the Platonic view that Semen is formed in the brain. To make the similarity more complete, some detected a fancied resemblance between the Pineal Gland and the Penis.

The *Pineal Gland*, to which so much importance was subsequently ascribed, served, according to Galen, mainly for the support of the large veins in that district.

Some thought that the conarium acted as a watchman to prevent overflow of the spirits from the third to the fourth ventricle,[1] just as the pylorus prevented undigested food from passing into the intestines. But Galen ascribed this office to the Processus Vermiformis of the Cerebellum.

The *Processus cerebelli ad corpora quadrigemina* are simply alluded to as tendons (τένοντες).

The *Processus vermiformis cerebelli* closes in the " iter " between the third and fourth ventricles.

He adopts from Herophilus the name Calamus scriptorius (ἀναγλυφή κάλαμου) for the lower end of the fourth ventricle.

The *Hypophysis cerebri* is regarded as the gland of the ventricle (ὁ ἄδην της κοιλίας). He evidently refers to the infundibulum under the name Πύελος καὶ χώνη (II, 709, "Vat and Funnel"). Cf. note, Hypophysis Cerebri (p. 131).

Cerebral circulation. Galen does not describe the sinuses one by one, but refers to them and also to the torcular Herophili termed by him λήνος or " wine press "—a term which is difficult to explain in this connection. He compares the sinuses to flutes into the orifices of which blood passes through the skull.

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[1] This may have suggested to Descartes his whimsical views of the importance of the pineal gland as the seat of the soul.

The blood-vessels named after him, Venæ Magnæ Galeni, are mentioned in various places.

Galen's description of the arterial supply of the brain is so inaccurate that as Hoffmann, Sprengel and Daremberg have pointed out it can only have been taken from some mammal.[1] Indeed, centuries later Vesalius taunted Galen with having never dissected a human body.

His notes on the spinal marrow are very short; he connects it directly with the brain and speaks of the Calamus scriptorius as a part of the marrow. He also mentions an 'Απόφυσις Νωτιαῖον μυελοὺ, which Falk thinks may correspond to the Pons varolii.

According to him the cord terminates at the end of the spinal column.

Galen, like Plato, regarded the brain as the seat of the soul; and, indeed, of the noblest part of the soul, namely, of reason, imagination, memory, thought and judgment.

The nature or essence of the soul (*το πρωτόν ὄργανον*) is the *πνεῦμα ψυχικόν*, perhaps the soul itself, and the brain is the source of this *πνεῦμα* or animal spirit.

The brain is the site of the reasoning soul (*λογιστική ψυχή*), the heart that of courage (*θυμοειδὴς*), the liver that of the desires (*ἐπιθυμητική*).

From the *heart* (site of the *vital spirit*, *πνεῦμα ζωτικόν των πρός* Γλαύκον *θεραπευτ. βιβ. α΄. κεφ ιε΄*, XI, 60) the *vital spirit* is sent throughout the blood-vessels, the multiplicity of which was not without reason, to the body and to the brain, partly from the veins, but far more from the arteries. In the brain itself the *πνεῦμα ψυχικόν*, or animal spirit, was formed from the vital spirit, and the elaborate *Retiform plexus*, *Δικτυοειδὲς πλέγμα*, called by Herophilus *Θαυμάστον πλέγμα* (*π. χρ. σφυγμ*, V, 155), which surrounded the *Hypophysis cerebri* and lay between the *Cerebellum* and fourth ventricle, served for this purpose.

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[1] Hoffmann, *Commentarii in Galeni de Usu Partium*, Lib. XVII, p. 208. Sprengel, *op. cit.* II, 152. Daremberg, op. cit. I, 575; II, 194. *Traductions des Œuvres Anatomiques, Physiologiques et Médicales de Galien.*

The change was made possible by the slowness of the circulation through the vessels of the Plexus.

He compared the mechanism with that of the testicular vessels for the elaboration of semen, and those of the breast for secretion of milk.

When the vital spirits were sufficiently prepared they were breathed out into the ventricles of the brain as animal spirit.

Hence the importance of the ventricles as a place of storage for *πνεῦμα*.

As evidence of this he mentions that in a living animal a skull bone may be removed, the meninges torn with hooks, or pieces excised, without causing paralysis; that the brain itself may be incised, but the animal will not lose sensation or power of movement unless the ventricle be opened, whilst if the ventricle be closed again (*συναχθείσων των κοιλίων*) sensation and power of movement will return (V, 606).

He attached even greater importance to the *fourth ventricle*.

Erasistratus had attributed the fact that animals were rendered lifeless by a blow over the first cervical vertebra, to the injury sustained by the *meninges*, but Galen says it is brought about by injury or uncovering of the fourth ventricle itself.

The brain and cord shared the importance of being the centre of sensation and voluntary movement.

But neither brain nor spinal cord had any part in *involuntary* movements. In support of this assertion Galen referred to his observations on sacrificed and vivisected animals whose hearts continued to beat after their removal from the body.

As evidence that the cord derives its functional capacity solely from the brain he showed that on complete section of the cord all the parts below the section are deprived of motion and sensation.

Hemisection of the Cord

Galen, again, made frequent longitudinal and transverse hemisections of the cord, and demonstrated that the result of transverse hemisection is to deprive the limbs on the corresponding side of the section of motion below the level of the lesion. He does not appear to have noticed any affection of sensation thus produced on the opposite side. (*περὶ ἀνατομικὴς ἐγχειρησίως. βιβ. ὄγδ. κεφ. ϛ′*, II, 683.)

The sovereignty of brain and cord over limbs and organs was due to the fact that the nerves arise from them, and not, as Aristotle thought, from the heart, nor from the meninges as Erasistratus had believed.

He confirmed the observation of Aretaeus that lesions of one side of the brain may cause paralysis of the opposite side of the body, and explained the occurrence as Aretaeus had done by assuming that decussation takes place somewhere on the motor tract.

Nerves

Galen in his earlier books uses the word Ν*εῦρα* in two different senses, as ligaments and as nerves. He speaks of the form of nerves which bind the bones together (*το ἔυδος νεύρων τῶν συνδετικῶν τῶν συνεχόντων τὰ ὄστεα πρὸς ἀλλήλα*), or ligaments, and of *nerves* themselves as organs of sensation and voluntary movement (XV, p. 204; Max Simon, IV, 6). But in Book XIV, recently translated from the Arabic, he draws a careful distinction between Nerves which arise from the brain and cord, ligaments which bind the bones together, and tendons which form the origin and insertion of muscles. He derived Νεῦρον from Νεύειν "to bend," and Τένων from Τείνειν, "to yoke."

The arteries and veins he regarded as organs of *involuntary* movement (IV, 372).

Sensory nerves were distinguished from motor by being softer than they. They supplied the skin, vessels, bladder, uterus, intestines, glands and teeth.

The cerebral nerves were softer than any others. But all other motor nerves were hard ; they supplied muscles, and were harder than the brain, softer only than the bones.

Muscles and nerves together were the organs of movement. He emphatically denied, however, that the heart is a muscle.

The confusion between *nerves* and *tendons* is explicable by his view that a nerve inserts itself into a muscle, becomes divided into branches, or what we should now call connective tissues, which reunite and leave it in the shape of a tendon, which, however, is reinforced and larger than the nerve entering the muscle.

In other words, the muscle becomes changed into a nerve, called indifferently Νεῦρον or Τένων, or sometimes Τόνος.[1]

In voluntary movement Galen, according to Falk, speaks of the action of the nerves as quite mechanical. Springing from the brain like brooks from their source, they acted as reins for governing the movement of muscles.[2]

But Galen discussed other views on the nature of nervous action to which I shall again refer.

Many organs, e.g. the eyes, ears and tongue, have both soft and hard nerves.

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[1] Until the sixteenth century, when Vesalius declared the contrary, muscular movement or contraction was held to be produced not by the fleshy part, but by the fibrous parts of muscles, and their power to effect this was due to the animal spirits reaching them along the nerves.

[2] I have been unable to trace the passage to which Falk refers.

The hard motor nerves, he said, spring preferably from the spinal cord, the others from the soft brain.

But a soft nerve, after leaving the brain, may become hard and dry like a motor nerve, into which, in fact, it is changed.

He speaks of special forms of nerves, which spring from the junction of the brain and cord, as being intermediate between the hard and soft.

Bones, cartilages, ligaments, fat, and certain glands, were nerveless. But other glands whose function is absorption are well supplied with nerves and blood-vessels.

He uses the term Νευρωδὴς as implying "rich in nerves," and also "sinewy," as for instance when speaking of serous membranes, and of the Corpus cavernosum. The Penis itself he calls Συριγγώδες Νεῦρον —a tube-like nerve.

De usu Partium: λογ. ι′. κεφ. β, IV, 220.
De locis affectis: ζ' κεφ. ϛ′., VIII, 447.

Special Anatomy of Nervous System

Cranial nerves. The special sense nerves have their roots in the brain. The cranial nerves are covered by the membranes. Hence the error of Erasistratus in asserting that the nerves arise from the meninges.

The olfactory nerves are not described by Galen as such. He refers to them as apophyses of the brain arising from the lateral ventricles.

He devoted a book to the sense of smell, which he recognized was closely allied to the sense of taste. (*περί 'Οσφρήσεως ''Οργανου*, II, 857–886.)

ALCMÆON[1] had already referred to the appreciation of smell from the nose to the brain, and denied that the sense of smell was situated in the mucous membrane of the nose.

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[1] A pupil of Pythagoras who flourished about 500 B.C. He is said by Plato to have been the first anatomist of animals, and to have discovered the Optic Nerves and Eustachian Tubes. (Baas, p. 89.)

Scents and odours were conveyed through the orifices of the cribriform plate. These were valvular, and served not only to convey scents to the brain, but also for purification of air respired by the brain.

Thus the cribriform plate served for respiratory functions indispensable to life, and functions designed to embellish it. Τὴ *μέν ἔις ἄυτο τὸ ζῆν ἀναγκαία τὴ δ'ἔις τὸ βέλτιον·ζῆν* (III, 650).

The direct passage from nose to brain accounted for the fact that sternutatories and pungent odours were beneficial in torpor, lethargy and carus, whilst strong odours caused headache.

The sense of smell might be abolished by cerebral lesions, e.g. of the ᾽*Απόφυσις* itself (olfactory nerve) or of the cribriform plate, or of the nasal cavities—for instance, by polypus and other excrescences.

He mentioned abnormalities in the olfactory sense, subjective sensations of evil odours. To some persons all things smelt alike. By others agreeable scents could not be borne. This condition when occurring suddenly often presaged an illness. Hippocrates had already dwelt on the importance of investigating the sense of smell in such persons. This sense of smell was also protective in preventing harmful odours from being inhaled together with the *πνεῦμα*.

Optic Nerves

These are Galen's first pair of nerves; the softest of all; most like the brain itself, and therefore not true nerves. They alone of all nerves are hollow, and in them alone could be seen a lucid spirit (᾽*Αυγοειδές πνεῦμα*) flowing to and from the eyes. This had led older anatomists to consider all nerves as hollow. He was disinclined to accept this view, saying, "Μ*η πᾶσι τοῖς* νεύροις ὑπάρχειν πόρους" but agreed that the canals in other nerves might be too small to be visible.

Even in the case of the Optic Nerves he admits that it is difficult to convince oneself of the existence of a canal which would hardly admit a hog's bristle. (Lib. XIV, p. 170.)

He may have been acquainted with the Arteria centralis retinae, for he attributes all kinds of visual defect to blockage of the optic canal. He also showed that total blindness results from division of the optic nerves.

The alleged hollowness of the optic and other nerves was hotly contested even as late as the end of the seventeenth century.

The origin of the optic nerves Galen places on the fore part of the lateral ventricles (*De usu Part.*, XVI, iv, 275–76). But in one passage (v, 613) he traces them to the under horn, or to what is still called the Cornu ammonis, and this Douglas (*Bibliographiæ anatomiae specimen*, Leyden, 1734, p. 22) regarded as a special instance of Galen's sagacity. I do not know why, considering that the optic nerves do not arise from the Cornu ammonis. It is certain that Galen did not trace the optic tracts to their actual origin in the Optic Thalami, although he says the nerves arise from that part of the anterior lateral ventricle which is like a chink or crevice (Θάλαμη).[1]

In time the word Θάλαμος, bedchamber, became substituted for Θάλαμη. Bedchamber suggested "pillows," and from their resemblance to pillows the Thalami Optici were so designated.

Galen flatly denied the assertion of Rufus of Ephesus (A.D. 50) that the optic nerves crossed at the chiasma. They only joined and reinforced each other, so as to prevent double vision, and also to strengthen the power of one eye when the other was destroyed. When one eye is closed, he said, the pupil of the other dilates, which proves that the power of one eye is reinforced by closure of the other. (*περί ἄιτιων συμπτώματων. β. α. κεφ. β.*, VII, 89.)

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[1] Ἔνθα γὰρ ἐκάτερον τῶν προσθίων κοιλιῶν τελευτᾷ πρὸς τὰ πλάγια, τῶν ὀπτικῶν νεύρων ἐστὶν ἡ ἔκφυσις καὶ ἅυτη γε τῶν κοιλιῶν ἡ οἷον Θαλάμη οῖ ἐκεῖνα τὰ νεῦρα γεγονεν.

This use of the chiasma, he said, was told to him by a god in a dream—a much higher authority than Rufus of Ephesus. He was not acquainted with the fourth and sixth nerves, but described the *oculo-motor*—or third nerve—as supplying the muscles of the eyeball. With him it is the second pair, division of which rendered the eyeball motionless (Bk. X, p. 26; Max Simon).

He is unaware of the movements of the pupil associated with other ocular movements.

The description in general of the eye is evidently taken from animals, not from man, as Kidd points out (*op. cit.* p. 333).

His third and fourth pair compose the Trigeminus; the fifth the Portio dura and mollis; the sixth the Vagus, the Glossopharyngeal and Accessorius; the seventh is the Hypoglossal.

Auditory Nerves

Earlier writers held that air entered the head, became shaken by the voice, and hence the sensation of hearing. (*περί φιλόσοφου ἵστοριας κεφ. κς′.*, XIX., 309.) Galen taught that a nerve from the fifth pair served the sense of hearing also.

Marinus (about A.D. 100) spoke of only one pair of nerves, but in fact there were two (namely, the facial and auditory of later writers). He enumerated seven cranial nerves and also discovered the inferior laryngeal nerves (Baas, p. 157). Galen described the entrance of the auditory nerve into the temporal bone, together with the Dura mater. It was harder than other cerebral nerves as it had to bear the vibrations caused by the voice.

He observed the entrance of the facial nerve by the canal hitherto called "the blind," and afterwards known as the "Aqueductus Fallopii."

He described its exit, the facial muscles which it supplies, its communications, and its formation of what was subsequently called the "Pes anserinus."

His account of the trigeminus is obscure, but he recognized that it supplied the nerve of taste to the tongue[1] (*lingualis*) and also the muscles of mastication, gums, teeth, and skin of the face.

The Glossopharyngeal is called by Galen sometimes the small tongue nerve, sometimes the throat nerve, and sometimes the nerve of the tongue and throat.

Section of it, he said, increased the hoarseness and stridor produced by cutting the recurrent laryngeal.

According to Falk (*op. cit.*, p. 36), Galen did not recognize the hypoglossal nerve.

However, in the *De Nervorum Dissectione*, Vol. I, p. 193, he says: "There remain the seventh pair of cerebral nerves of which the greater part supply the muscles of the tongue." Daremberg (Tome I, p. 502) thinks that Galen's seventh nerve is the hypoglossal, but Falk disputes it (p. 37). Kidd regarded Galen's seventh nerve as the lingualis. All doubt on the question is cleared by his statement in Bk. XI, that section of one of these "hard nerves" paralyses one-half of the tongue, and if both nerves be divided the whole tongue loses all power of voluntary movement.

Galen described the *vagus* and its superior and inferior ganglia with great minuteness and traced it to the larynx, trachea, œsophagus, lungs, heart, stomach and intestines.

He did not, however, distinguish the "accessorius" in his earlier books, but in the later he describes its origin and supply to the sternomastoid and trapezius muscles.

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[1] *δι' αὐτῶν ἡ τῆς γευσέως αἴσθησις γίγνεται.* (Π. *νευρ. ἀν*, II, 837.)

He knew of the distribution of the superior laryngeal nerve, and claimed to be the first to trace the *Recurrent Laryngeal nerve*, and to explain the stridor and affections of voice occasioned by its injury or paralysis (VII, 15).

Note on Ligature of the Vagus

Galen showed that the alteration in the voice which had been noticed to follow tying the Carotid, was really due to inclusion of the vagus in the ligature, and not to cutting off the supply of air in the vessel.

In this connection it will be remembered that the ancients believed that the arteries contained air and not blood. The Trachea itself was called the Arteria aspera, and was held to convey the voice from the heart.

The doctrine that the arteries were air-carriers explains the use of the term asphyxia in its modern sense. Asphyxia (*α* priv. Σφύξις, the pulse) literally means pulselessness, but as the pulse-beat was attributed to the pressure of air or spirits in the vessels, it followed that pulselessness also meant airlessness or deprivation of air.

Not the least of Galen's services was that he proved that the arteries contained blood by putting a double ligature on them, and showing that the intervening portion was filled with blood and not with air alone.

An interesting result of the doctrine that the nerves were hollow in order to carry animal spirits was that ligature of nerves was practised at amputations with a view to preventing the escape of the animal spirits by all the earlier surgeons, including Paré in the sixteenth century.

In the seventeenth century the practice fell into disrepute. Peter Marchetti (1589–1675) said:

"Nerves and tendons must never be sutured, for the practice is often followed by fatal Tetanus."

And so nerves and tendons accidentally divided remained unsutured until Haller showed in the late eighteenth century by his experiments on animals that the fear of causing tetanus by suturing nerves was groundless.

He denied that the vagus was indispensable to the heart's movements because the heart continued to beat after removal from the body.

The office of nerves supplying the abdominal organs was to warn them and protect them from the presence of injurious substances.

He had some knowledge of the *sympathetic* nerves, which he believed supplied the lungs and abdominal organs, having their course along the spinal column, and being closely associated with the spinal nerves. The use of the Ganglia was to strengthen weak nerves. He traced the origin of the sympathetic to the Carotid plexus in the skull, and said it was derived from the four central nerves, Portio dura and Trigeminus.

His account of the Spinal Nerves and their origin is accurate on the whole (Περί χρείας, Lib. XII, c. 15). But here he gives their number as fifty-eight and as sixty in another place.[1] The ganglia on their posterior roots apparently escaped his attention. Koyter, in the sixteenth century, was the first to describe the spinal roots with accuracy.

Galen recognized the spinal origin of the phrenic nerves and their insertion into the diaphragm, which, he said, is not supplied by *cerebral* nerves as had falsely been stated (Περί χρείας, XIII, 5).[2]

His account of the Brachial plexus is not more inaccurate than might be expected from observations made entirely on animals.

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[1] Probably he counted the spinal nerve roots as nerves and so doubled their number. If so, he was not far out in making the total 29 or 30 × 2 instead of 31 × 2.

[2] He derived the phrenic nerves from the 4th, 5th and 6th cervical, instead of from the 3rd, 4th and 5th.

Of the *Brachial Nerves* he mentions the radial, ulnar and median, without designating them as such. He thought that the anterior branch of the first dorsal nerve supplies the hand (cf. Daremberg, *op. cit.*, Tome II, p. 66, note). This is not quite correct, but it is nevertheless true that the last cervical and first dorsal segments do supply the small muscles of the hand and fingers, and also the fingers on the ulnar side with sensation through the first dorsal root.

Reference to the *cutaneous* nerves in either extremity is scanty, but he mentioned the Thoracic and the *Cutaneus femoris posterior* and three other cutaneous nerves to the lower extremity.

According to Daremberg, Galen's fifth brachial nerve is the Radial, but Galen describes it as supplying the inner side of the upper arm (ʼAν ἐγχ, III, II, 363), and says it is the weakest of all (i.e. a sensory nerve), and supplies no muscles.

The *crural* and *sciatic* nerves are mentioned, but not under these names. The division of the sciatic into its ultimate branches is not emphasized. The pelvic nerves are, however, rightly placed.

In all his anatomical accounts Galen attempted to give reasons for the phenomena and facts which he observed. Sometimes they are obviously wrong. For instance, he thought that the chief brachial nerves were on the inner side of the arm because inner movements are most important.

As regards Pathology of the Nervous System

Galen ascribed great importance to pain as a symptom and insisted on its nervous origin. Pain was a troublesome and pleasure an agreeable sensation of the nerves. Itching and tickling were minor kinds of pain. He agreed with Hippocrates' aphorism, " Those suffer pain whose nature becomes changed and spoilt," and with Plato who said in the *Timæus* that all sudden departures from Nature are painful and all sudden returns are pleasurable, but gradual changes awake no sensation.

Irritation of special sense nerves produced not actual pain but alterations in the special sense faculties ; for instance, loud noises deafen ; strong light dazzles ; bitter, sour, and astringent substances destroy the sense of taste ; whilst common sensation is altered by cold, heat and injury.

Ear-ache is not due to irritation of the auditory nerve but to that of a nerve of common sensation.

ARCHIGENES (A.D. 48–117) had divided pains into dragging, severe, itching, stinging, writhing, dull, immoderate, cramping varieties, and had claimed to discover from these characters the seat of disease.

Galen without agreeing altogether with Archigenes yet admits that the quality of pain is of diagnostic value.

He described the character of pain in different forms of headache—acute and chronic—headaches due to affection of the meninges and of the pericranium. Meningeal headaches were characterized by piercing pain at the back of the eyes, exacerbated by loud noises, bright lights and movement. He discussed Hemicrania and its gastric origin, and also said that it might be due to intracranial or pericranial lesions.

Colic might be due to affection of the small or large intestine as the consequence of retention of cold " pneumata." He dwelt on the importance of distinguishing simple colic from the pain and other symptoms due to ἐιλέος or twisting of the bowel, and to renal calculus. The methods of differential diagnosis are clearly and accurately given.

'Ισχιάς, or Sciatica, defined as a sharp periodic pain in the hip which may extend to the back of the knee and calf of the leg, is not attributed to affection of the sciatic nerve itself, but of the ligaments about the hip joint, a view which finds favour in modern times. There is no doubt that a number of cases of sciatica and brachialgia are caused by what Sir W. Gowers has called "Fibrositis" and consequent neuralgia, from pressure on and irritation of the nerves.

Neuralgia itself is not described by Galen.

He advocated local bleeding in the treatment of sciatica and quoted a case of chronic sciatica (Ἰσχίας) which was cured by a wound which injured an artery near the hip (*Περί φλεβοτόμιας θεραπευτικόν. βιβ. κεφ. κγ*', XI, 315).

Like colic he said it was often cured by purgatives.

He approved of Hippocrates' aphorism, "When two pains occur simultaneously in different parts the greater pain obscures the less." It was the same with sorrow, the greater grief outweighs the less; but he added ironically that one must beware of carrying the principle into practice and trying to drive out a little pain by inflicting a greater.

Toothache, for instance, he said is cured by extraction of the offending tooth, not because the pain of extraction is greater than toothache itself, but because the tooth which caused the pain is removed.

Anæsthesia

Although Galen did not fully describe the cutaneous nerves, he was aware of their existence.

Sensation, he said, depends on the nerves distributed to the skin; motion on the nerves which supply muscles.

Paralysis both of motion and sensation may occur. The difference is only one of degree. More nervous power is required for motion than for sensation. There may be sufficient for sensation though not enough for motion.

In the most severe cases of paralysis both motion and sensation are lost (*De locis affectis*, Lib. I, cap. 6).

Galen was well aware of the results of section and ligature of nerves. He demonstrated the result of section of the optic, oculo-motorius, glossopharyngeal, hypoglossal, recurrent laryngeal nerves, but it is strange that he does not seem to have anticipated Sir Charles Bell in dividing the branches of the fifth and Portio dura. But he divided the fifth cervical and demonstrated the resulting paralysis of the shoulder muscles. As already mentioned he practised section and hemisection of the cord and showed how all the parts below the lesion were paralysed on the same side only, after hemisection.

Hemiplegia

The term Hemiplegia seems to have been first used by Paulus of Ægina (A.D. 625–690). It is not found in earlier writers, though the condition was well known and described.

Galen pointed out that paralysis of one side of the body might be of cerebral or spinal origin, and that if cerebral the face muscles were involved. He also knew that the face alone, or the tongue and lips, and also isolated muscles or groups of muscles might be affected. In the latter case the lesion was usually to be found in the corresponding nerve roots of the cord.

He mentions with great pride, on three separate occasions, his skill in diagnosis and treatment in the case of Pausanias the Sophist, who suffered from anæsthesia of the two inner and part of the middle fingers of the left hand. All other physicians had applied remedies to the fingers themselves, but Galen ascertained that the patient in a carriage accident had met with an injury to the upper dorsal region of the spine. Accordingly he removed the dressings from the fingers and placed them on the back and thereby cured the patient rapidly (*De locis affectis*, Lib. III, c. 14 ; I, 6—III, 2).

If the spinal marrow, he says, be affected about the fifth cervical vertebra the hands will be wholly deprived of sense and motion; if about the sixth the paralytic affection of them will be more partial; . . . and if below the eighth they will not be affected at all (*De Sympt. Causis.*, Lib. I, c. 5; VII, 112).

Paraplegia

The term was used by the Ancients in different senses, but by none in its modern acceptation. HIPPOCRATES called all paralysis which followed apoplexy paraplegia.

ARETAEUS said that the "vehement apoplexy" of Hippocrates was so called if it affected the whole body, but paraplegia when it affects the leg. He himself applied the term to loss of motion and sensation of some particular part, such as a hand or limb (*De Morbis Diut.*, Lib. I, c. 7).

So late as the seventeenth century Boerhaave defined paraplegia as a palsy of all parts below the neck (*Aph.*, 1018).

Galen followed Hippocrates in regarding paraplegia as complete motor paralysis of the face and extremities resulting from apoplexy.

But he was also well acquainted with what is called pressure paraplegia, the result of disease or dislocation of the vertebræ.

The severity of the symptoms depended on the situation of lesion. They were most dangerous when the injury or disease involved the respiratory nerves, especially the phrenic.

Galen also spoke of *paralysis of special organs*. For instance, Apnœa was due to paralysis of respiration; Aphasia to paralysis of vocal organs. He also mentioned paralysis of sphincters; of the bladder and rectum, causing retention or incontinence of urine or incontinence of fæces.

He related the case of a boy who suffered from incontinence after fishing on a cold day (*De locis affectis*, Lib. IV, c. 7), and adds that this may be the result of sitting on a cold stone or remaining too long in cold water.

He was acquainted with paralysis due to pressure on nerves, by tumours or inflammatory exudations or by fractures and dislocations (*De Sympt. Causis*, Lib. I, c. 5).

Apoplexy

Apoplexy with Galen and his predecessors was but a clinical conception. Its causation by cerebral hæmorrhage and vascular occlusion was unknown, and remained so until Cerebral Embolism and Thrombosis were described in the last century by Kirkes and Virchow. Galen followed Hippocrates in attributing apoplexy to an accumulation of phlegm in the cavities of the brain, which obstructed the passage of animal spirits from the ventricles (*De locis affectis*, Lib. III, cap. xi.).

An apoplectic was one who became suddenly senseless as if struck by lightning and lost all motion except that of respiration.

Apoplexy and paralysis only differed in degree. Apoplexy was universal palsy and palsy was partial apoplexy.

The predisposing causes were emotion, plethora, sloth, drunkenness and gluttony. Galen thought that cold was an important factor, as he had known the feet to become dead and putrid—that is to say, " apoplectic " as the result of exposure.

The symptoms of cerebral hæmorrhage are graphically described by Hippocrates, Aretaeus and Galen. All agreed that the worst forms of apoplexy were those in which stertor and foaming at the mouth occurred. Galen rightly attributed death to failure of respiration, and said that the most dangerous symptom was laborious and intermittent breathing.

He divided apoplexy into four varieties, according to the degree of affection of respiration. Hippocrates had spoken of the severe and the mild forms. "The strong form was impossible and the weak not easy to cure" (*Aph.*, II, 42).

Treatment of Apoplexy

It is impossible to give in detail the history of treatment in apoplexy.

Treatment at the present day is as unsettled as in the days of Hippocrates, owing to the difficulty which will always exist in diagnosing the cause of the seizure.

Innumerable tomes have been written on the indications for bleeding, giving emetics, purging or stimulating and counter-irritating since Galen's day. I can only say that the vast consensus of opinion amongst our forefathers as to the efficacy of blood-letting is worthy of consideration at the present time. But the rationale of its success only consists in its power to relieve asphyxia by lessening the labour of a right heart distended by venous blood.

Venesection employed for any other purpose than to relieve asphyxia was bound to bring the treatment into its present disrepute.

Convulsive Affections

Galen regarded tremors as a minor degree of paralysis. He distinguished "intention" tremors, *τρόμος*, from *πάλμος*, "quivering," or movements occurring during rest (*Myoclonus*).

They were due to deficiency of *animal spirit* in the nerves—not in the arteries, as Praxagoras taught.

They might be the result of acute cerebral diseases, as Hippocrates said in the *προρρητικόν*. Here he, perhaps, referred to athetosis or to what is misnamed post-hemiplegic chorea. *Chorea* itself he does not describe.

Convulsions he regarded as involuntary imitations of voluntary movements. When the face was affected they originated in the brain, when the face escaped, convulsions were due to affection of the upper part of the cord. He attributed them to plethora, or to anæmia due to loss of blood ; to exhaustion as in cholera and diarrhœa, and to over-feeding as in the case of infantile convulsions.

Spasms were called by different names according to their situations. By *spasmus* " *cynicus* " he probably meant spasmodic tic. Cf. Aretaeus (p. 81).

Strabismus he attributed to spasm of eye muscle, but also recognized it as a paralytic affection (in the Ὅροι Ἰατρικοί).

Chordee was spasm of the seminiferous vessels in gonorrhœa, but only occurred during erection.

Hiccup was an affection of the cardiac end of the stomach, not a true spasm, for Galen regarded the stomach as non-muscular. He did not recognize that it is a spasm of the diaphragm.

For hiccup he recommended taking long breaths and also sternutatories. Eryximachus, as related by Plato in the *Symposium*, gave similar advice to Aristophanes, when, overcome by hiccup, he was unable to make his speech at the Banquet.

With *tetanus*, *opisthotonus*, *emprosthotonos*, Galen was fully acquainted. He ascribed *tetanus* to wounds, especially cross-cuts of the nerves.

Trismus is also mentioned. He followed Hippocrates in saying that patients who survive the fourth day of *tetanus* are out of danger (*Aph.*, V, 6).

Like all his predecessors and his successors for many ages, he looked upon hysteria as an uterine affection.

The *uterus* was likened to a wild beast which roamed about the body seeking impregnation. If unsatisfied, it gave rise to all the phenomena called Hysterical.

He described *globus hystericus*, *aphonia hysterica*, and trance, in which the person lies as if dead, respiration can no longer be perceived, but must happen, he says, " through the arteries."

He held that hysterical convulsions are only dangerous when resulting from trauma, suppression of menses, chills, or after miscarriages.

Rigors

Galen was familiar with "rigors" as shiverings and sense of chill affecting the whole body. He recognized their importance as marking the onset of many fevers—their occurrence in tertian and quartan malaria. He attributed rigors to passage of yellow bile into the muscles.

Like Hippocrates, he thought they sometimes announced a crisis, but when they occurred without abatement of fever and in debilitated subjects, they were of very unfavourable omen, and also in cases of suppuration.

He placed their origin in the central nervous system.

In speaking of vertigo (δίνος) with temporary restriction of vision (σκοτοδίνος) occurring with nausea and palpitation, he perhaps alluded to migraine. He regarded it as a brain trouble, the primary cause of which was often in the stomach.

Epilepsy

The ancients in general believed that epilepsy was due to accumulation of pituitous humours in the cerebral ventricles, and that the symptoms were the efforts of nature to relieve the pressure so caused.

The symptoms were as well known and as well described by the older writers as they are now. The only considerable addition to our knowledge in modern times has been in the recognition by Dr. Hughlings Jackson of the special class of fits which bears his name.

Galen placed the origin of epilepsy in the brain, but said it might proceed from the stomach or from more distant organs indicated by the situation of the cold aura which marked its onset, and arose from irritation of a peripheral nerve.

It was frequently arrested at puberty and by the occurrence of quartan fever.

Galen wrote an interesting account of an epileptic boy aged thirteen and of the aura which he experienced (*Consilium de puero epileptico*). The fits, he said, were associated in this case with derangement of the stomach, and the most useful medicines were found to be those which purge and strengthen (*De locis affectis*, Lib. V, c. 7).

The treatment in general, however, does not seem to have been more efficacious than in the present day, judging from the enormous number of drugs which he advocated and from his conviction that carrying a peony root was of service.

He mentions *Catalepsy* amongst other nervous diseases.

He described four kinds of *Hydrocephalus*, in which fluid was extravasated between the skull and the pericranium; the dura mater and the skull; the meninges and the brain; and in the ventricles of the brain itself.

Summary of Neurology in Galen's Time

Herophilus and Erasistratus, Aretaeus and Galen were the founders of the physiology of the nervous system.

Between them they succeeded in overthrowing the Aristotelean doctrine that the source of all nervous action and mental faculties and the seat of the soul itself were in the heart, that the brain was merely a bloodless and cold gland whose office was to cool the heart.

Galen accepted the doctrine of Plato that the brain and not the heart is the centre of voluntary movement, sensation, thought, and all the highest mental faculties, although he still credited the heart with being the seat of anger, passion and courage, and the liver that of animal desires.

Motion and Sensation were due to the action of animal spirits generated in the heart, but elaborated in the ventricles of the brain and thence distributed by the agency of nerves throughout the body. The precise manner in which the spirits acted on the nerves he was unable to determine (*De Hip. et Plat. Placit*, L. VII, c. 4). He was of opinion that the mind acts upon the body by means of the animal spirits and nerves, and that the will being placed in the brain, at the origin of the nerves, gives the principle[1] as beginning of motion to the first nerves, and by them to the muscles. But he said: "We cannot absolutely pronounce whether the power flows from the brain through the nerves to the limbs, and the essence of the spirit reaches the feeling and moving parts; or whether it in some way or other strikes the nerves so as to induce in them a powerful change (Ὡς ἀλλοιῶσαι σφοδρῶς αὐτά) which is propagated to the parts to be moved; whether there is in each nerve an innate spirit belonging to it, which is struck by something coming as a sort of messenger from the first principle; or whether the spirit flows from the brain to parts on every occasion when we will to move them; or whether in the third place there is merely a change in the qualities of parts contiguous to each other (which appears to me to be hinted at by some who say that the influence is a power without a substance) I am not able easily to determine" (Cooke, Vol. I, p. 12. *De Hip. et Plat. Placit.* L. VII, c. 4).

Galen thus had three if not four different conceptions of the nature of nervous action:—

1. That it was due to an actual substance, *animal spirit*, which flowed from the brain through the nerves to distant parts.

2. That a nervous impulse set up what we should now call molecular or catabolic changes in the nerves themselves or in the area of their distribution.

3. That the nerves were simply conductors of impulses started from above, the nerves acting mechanically like reins to the muscles, and the impulses being due to a "power without a substance."

Galen did not recognize the distinction between

[1] ’Αρχήν κινήσεως.

afferent and efferent impulses, but in other respects the questions which he propounds find their counterpart in the present day.

The terms Animal and Vital Spirits were at first but figures of speech, to convey the notion of a mysterious intangible influence—a kind of air or very subtle fluid generated in the brain and capable of endowing the body with motion and sensation through the nerves. Our modern use of names such as Nervous Energy and Force conveys the same ideas.

The chief objection to the use of such terms as Animal Spirits was that gradually they acquired a materialistic connotation—were regarded as physical entities—and hence arose many absurd doctrines as regards the phenomena of nervous action, and mischievous systems of treatment.

Galen had far more knowledge of the component parts of the brain than any of his predecessors. We have seen that he was acquainted with the nerves of special sense, or some of them, and with their course and function, that he rightly traced them to the Brain and not to the Meninges, that he knew those which are of medullary origin, that he was aware of the importance of the fourth ventricle; whilst, finally, he proved in contradiction to Aristotle that the brain itself was vascular, however faulty his description of the cerebral circulation may have been.

Although unaware of many of the functions of the cord, he yet demonstrated the chief results of Section and Hemisection of it.

He knew that nerves are motor, sensory and mixed. He ascribed three uses to the nerves: to carry sensory impressions to the organs of sense, to excite motion in organs of motion, and to enable the organs in general to discern what might be injurious to them—e.g. the Intestines (*De Usu Partium*, V, c. 9).

He believed that sensory nerves were soft, and motor nerves hard; the former soft to render them more impressionable, the latter hard to make them stronger, in accordance with their office. Mixed nerves were both hard and soft, to confer on them a certain sensibility. Sensory Nerves, originating from the soft part of the Brain, might become hard so as to enable them to assume Motor functions.

His experiment of dividing the various cranial and the fifth cervical nerves and his demonstration of the results were alone sufficient to illumine the whole field of Neurology.

His account of the nervous mechanism of the voice and respiration and the effects on both produced by section of the recurrent laryngeal nerves and vagus was a revelation to all but those who obstinately adhered to Aristotle's view that the voice proceeded from the heart, for the excellent reason that the trachea was next to it. The recent issue of the long-lost books on anatomy has rendered his claims as the earliest of Neurologists even greater than they were held to be.

It is true that he did not shine as an exponent of nervous pathology, nor indeed as a great clinician, such as Hippocrates was, but his acuteness, zeal and skill in experiment, his demonstrations of the structure and function of the healthy nervous system in spite of the quaint and far-fetched teleological views which he upheld will always place him high in the ranks of Neuro-physiologists.

Post-Galenic to Fall of the Empire (A.D. 476)

The time and place of Galen's death are unknown. With his disappearance there was an end to the progress of Neurology. Galen left no immediate disciples to take up his mantle. His truly scientific methods were hardly appreciated in his lifetime, partly, perhaps, on account of his somewhat aggressive manner in enforcing them. The Romans never had much liking for Greeks. Even when it became the fashion to imitate them they inwardly despised them and never rose to their intellectual level. It is true that many of the Greeks who settled in Rome were undesirables, as in the day of Pliny, who hated them, and especially those who practised medicine.

Galen became fashionable through his influential friends. Marcus Aurelius liked him because he happened to be a well-educated gentleman, and even consented to take his abominable treacle as a tonic.

No doubt his slashing criticism of the methodicists, whom he disliked, and the other so-called anatomists, whom he despised, tickled the fancy of the educated Romans who were yet quite incapable of grasping the value of his scientific researches. Like many a popular physician, his success in practice was chiefly due to his being a shrewd and cunning man of the world. He astounded his patron Boetius by discovering that his boy ate cakes on the sly, and all the world knew how he diagnosed love-sickness in a lady by observing the fluttering of her pulse when she heard the name of Pylades the dancer. He admits that he was inspired by a similar story told of Erasistratus in the case of Antiochus, who had fallen desperately in love with his stepmother, Stratonice. Erasistratus received 100 talents[1] for making the diagnosis. Galen does not mention his fee for curing Aurelius of the stomach-ache caused by eating cheese, but he received 400 aurei, or guineas, for a fortnight's treatment of the wife of Boetius. Her complaint was metrorrhagia.[2]

All the consultants in Rome met together over this case, but Galen remained in charge by proving to the satisfaction of the anxious husband that all the others were fools, and that he alone never made mistakes in treatment.

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[1] £24,000! (Kühn, Vol. XIV, p. 630; Vol. XVIII, B. p. 40).

[2] Boëtii uxorem uteri profluvio laborantem prater spem aliorum sanat. . . . quadrigentes aureos ad me misit, auxitque generosorum horum medicorum invidiam inde quod me laudibus extolleret (Kühn, Vol. XIV, p. 647).

On another occasion when his rivals were going to bleed a man, Galen in his sarcastic fashion advised them to be quick about it as the patient was on the point of saving them the trouble by bleeding from the nose, which immediately happened. Galen had seen that the left nostril was extremely injected, which the other physicians had not done. Such instances of common sense and sagacity were not calculated to increase his popularity as a consultant amongst the profession, and it is not surprising that many declined to accept his conclusions or to be convinced by his demonstrations solely on account of his arrogant and supercilious manner of conveying his instruction. He had some of the spirit of his mother, an ill-tempered shrew who sometimes bit her female servants.

Yet Galen's reputation was undeniably great during his life, though far exceeded by the estimation in which he was held for nearly fifteen centuries after his death.

At all times, however, it was his weakest side which appealed most strongly to his followers.

He showed a puerile vanity in his cunning use of the methods of Zadig to impress the ignorant public with his skill in diagnosis. He allowed his friend Glaucon to believe that he diagnosed Hepatic disease simply from feeling the pulse. He persuaded Eudemus, the old peripatetic philosopher, and also Marcus Aurelius, that his presence at Rome was indispensable in order to counteract the ignorance, rascality, and depravity of the medical profession. He never lost an opportunity of extolling himself at the expense of his confrères. Most of the cases which he records redound to his own glory and illustrate the confusion of his rivals.

From his own account one might think that none of his own cases ever ended fatally, unless maltreated by other practitioners. In this respect he does not bear comparison with Hippocrates, whose transparent honesty and sincerity of purpose in relating fatal cases led the uncharitable to say that all his patients died.

Galen's standard of professional ethics was loftier, perhaps, than that of his contemporaries, though certainly not high. He expressed great indignation with ladies who wished to dye their hair when turning grey, unless their object was to regain the waning affection of their lords. In such cases he taught them how to do it, thus salving his conscience and filling his pocket, too.

It is a relief to find evidence of kindliness to compensate for obvious defects in Galen's character. Called to attend a rich man's steward, he discovered that the illness was mental anguish. The steward had made mistakes in his accounts and dreaded their disclosure. Galen persuaded the master to pass the accounts without scrutiny, and the old slave recovered health and spirits in the belief that his error was undetected (XIV, 633).

Galen only tells the story to prove his skill in psychological diagnosis, but it shows that he was kind, and that Roman nobles were not always cruel.

Also his attempts to find remedies which were easily obtainable, for the benefit of poor fishermen who were stung or wounded by venomous fish, are to his credit (XII, 217).

Rancorous abuse of all who practise medicine, boastful and blatant self-assertion, are only now the panoply of Quacks. But, after all, in Galen's day they were regarded as legitimate means of arriving at distinction, and so we must deal charitably with his memory.

As the creator (Alcmaeon excepted) of experimental physiology he was ignored; as a fanciful theorist on the causation of disease, as a systematist in treatment and the advocate of a prodigious number of drugs and panaceas, he was worshipped.

After his death, or disappearance, the degradation of medicine went hand in hand with the decadence of Rome.

Dogmatists, Humoralists, Solidists, Methodicists, Pneumatists, Empyricists, Eclectics, all continued to wrangle with each other, and each sect could claim its victims by the score, as Pliny said. But this was not the worst; the whole science of medicine became contaminated by the lowest kind of mysticism, sorcery, magic and imposture, in spite of spasmodic efforts of some of the Roman Emperors to check the evil.

Hippocrates, who did so much to keep medicine pure from jugglery and witchcraft, was forgotten. Perhaps Galen himself, as an ardent follower of Plato, was partly responsible for the rise of Neo-Platonism, with its Demons or Familiar Spirits, Cabalism, Abracadabra, charms, talismans and horoscopes, and all the ghastly travesty of Plato's philosophy which degraded the practice of medicine.

Until the fall of Rome in A.D. 476, we meet with hardly any names of eminence.

The few exceptions are Philagrius and Posidonius, who practised about A.D. 360–75, and Oribasius, who lived from A.D. 326–403.

Philagrius and Posidonius protested against utterance of mystic words in the preparation of medicine. Posidonius wrote on "Phrenitis," described mania, nightmare, hydrophobia and catalepsy. He placed the seat of imagination in the anterior parts of the brain, and reason in its middle ventricle. In disease of the posterior ventricle he said recollection was destroyed, and with it other faculties.

Oribasius deserves mention for having at Julian "the Apostate's" request composed an epitome of Galen, and, indeed, of all the writers on medicine from Hippocrates upwards (*'Οριβασιου ἀνατομικα ἐκ των Γαληνου*).

He also wrote an introduction to Anatomy, based chiefly on that of Aristotle (Baas), which is significant of the general neglect of the study of this subject in his time.

Although Alexandria retained her reputation as a medical school even to the seventh century when the remains of her magnificent library were finally destroyed by the Saracens (A.D. 632 or 640 ?, Gibbon), there must have been a sad falling off in the instruction to be obtained there, since the days of the Ptolemies. Even in Galen's time, skeletons only were obtainable and not human bodies to dissect. The Museum and Serapeum, which contained not only books but collections of anatomical, zoological and botanical preparations, suffered on several occasions from fire.

The Museum was burnt down in A.D. 47, by extension of flames from Cæsar's fleet. Cleopatra probably restored it. It is said to have been burnt again during riots in the reign of Gallienus, about A.D. 265. The Serapeum was closed by the infamous Caracallus, A.D. 212–15, and burnt by the Christian Bishop Theophilus in A.D. 391.

The anatomical and other collections can hardly have escaped damage, and therefore the study of anatomy on which pathology and physiology depend must have been impossible—except from books—and remained so for many ages.

The prejudice against human anatomy has always existed. It is wholly natural and deserving of sympathy, although it has hampered science and sometimes does so still.

Orientals objected to post-mortem examination because they thought that the soul only escaped from the body by degrees after death, and therefore it was gross cruelty to practise it. Christians regarded it as a defacement of God's image. But in this matter they only voiced the general sentiments of mankind.

As regards the study of comparative anatomy and physiological experimentation—it seems that even the Methodicists, although they despised the tuition of human anatomy and physiology, yet practised vivisection, for Tertullian says, "Let Asclepiades investigate goats which bleat without a heart and drive away flies which fly without a head." But they seem to have derived no useful knowledge from their experiments.

After the fall of Rome, the Arabian ascendancy in medicine began, and was in its zenith between the eighth and thirteenth centuries.

In imitation of Alexandria the Arabians founded their Universities, Halls of Science, and Colleges of Medicine, at Bokhara, Cairo, Cordova and Bagdad.[1] Their teaching in medicine was based entirely on that of the Greeks, and to them we owe the survival of Greek medical literature. As translators of Galen and Hippocrates their services were of the utmost value to medicine, but beyond the introduction of new and chemical remedies, the resuscitation of Clinical Instruction as practised by Galen, the spread of general scientific culture, the emancipation of the practice of medicine from the hands of ignorant Christian priests and monks, they achieved but little progress.

Least of all did Neurology profit by their sway; we look in vain in the writings of Mesuë, Rhazes, Avicenna, Averroës, for any contribution to our subject, and simply because the principles of Islam made human dissection a deadly sin. Baas says that "a sort of dissection may still have been practised, e.g. by the Rabbi Ismail at the close of the first century. But he merely boiled and did not dissect the corpse" (p. 295). Probably he waited until decomposition was so far advanced that there could be no possibility of any portion of the soul being retained, and merely boiled the body to get the skeleton.

That some of the Arabians were acute observers and could distinguish between functional and organic paralysis is, however, shown by the following story:

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[1] Ferdinand of Castile took Cordova in 1236, and Bagdad fell to the Mongols twenty-two years later.

I choose the least indelicate version related by Boerhaave.[1]

The young and favourite wife of one of the Caliphs suffered from Hemiplegia. A physician promised to cure her provided that the Caliph would hold him indemnified for the methods which he used. This was promised, and accordingly in the presence of the whole court he rushed at the young woman and attempted to touch her feet. This outrageous affront to Oriental notions of modesty was immediately successful in curing the paralysis.

Revival of Anatomy

It is not known when or where human dissection in aid of anatomical studies was revived. Baas suggests that it may have been at Salerno by order of Frederick II[2] (1194–1250) in 1231, but it is certain that the Senate of Venice ordered in the year 1308 that a body should be annually dissected. Human anatomy was practised during the 13th century by Salicetti, Mondeville and Ricardus, who actually wrote an " Anathomia." (Baas, p. 295).

Mondino de Luzzi (1276–1326), however, was the first to make the study of human anatomy popular by his work (*Anatome omnium humani corporis interiorum membrorum*) published in 1316. But in deference to public opinion, Mondino did not dare to open the skull. Indeed, the method of dissection was crude. The body was opened by a " disreputable barber " with a razor. A demonstrator pointed out the parts with a wand and the professor read descriptions of them from a book. It should be remembered, however, that the professors of anatomy were also professors of surgery down to the nineteenth century. It is possible that the earlier anatomists refrained from soiling their fingers by dissection of dead bodies in the interests of their patients, and not from mere fastidiousness.

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[1] Prostat hic loci in Bibliothecâ publicâ liber Arabicus in quo scribitur, amatissimam Caliphi uxorem laborâsse paralysi unius lateris: Medicus Consultus dixit se posso sanare, nisi metueret iram Principis; ille Curam sibi gratam fore respondet; Medicus ergo conabatur pedes aegræ attingere, quod in Asia est signum impudicitiæ, unde illa valde irata voluit Medicum a se abigere, et hoc violenti nixu mox sanata fuit " (Boerhaave, *De Morb. Nerv.*, p. 688).

[2] King of Sicily.

Regular dissections were made at Prague after the year 1348, and after 1376 at Montpellier, by leave of Louis d'Anjou, on executed criminals. In 1517 the first public dissection was performed at Strassburg.

After Mondino, little further advance was made until the sixteenth century. In England, Henry VIII in 1540 authorized the "Masters of the Mystery of Barbers and Surgeons" to anatomize yearly four bodies of executed felons. Our own College was allowed a similar privilege by Elizabeth in 1565. Charles II. increased the number allowed to the Barber Surgeons to six, "provided they be afterwards buried."

Amongst celebrated anatomists towards the end of the fifteenth and at the beginning of the sixteenth century, may be mentioned :—

ALEXANDER ACHILLINI, of Bologna (1463–1525), who described the Olfactory Nerves as such—Galen, as we have seen, had not regarded them as nerves—and also the *N. patheticus*, or fourth nerve, which Galen did not observe.

Another was DELLA TORRE (1473–1506) who was aided by the beautiful plates of Da Vinci. The indebtedness of anatomy to Da Vinci, Michael Angelo,[1] Titian and his pupil Von Calcar, and Albrecht Dürer[2] should not be forgotten.

ALEXANDER BENEDETTO (1495–1525) and JEAN

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[1] In the South Kensington Museum are some accurately executed models in wax of the musculature of the upper and lower limbs, attributed to Angelo, and said to be studies for his colossal figure of David and other subjects.

[2] Jacob Buevmann, a Swiss, published an anatomy written in German, and adorned with thirty-eight plates after Dürer in 1575 (Baas).

FERNEL (1497–1558) gave special directions for the study of anatomy.

BENEDETTO (*Historia de Partibus Corporis Humani*) followed Galen's description closely. He did not yet distinguish corporal nerves from ligaments. He described seven cerebral pairs: (1) Optic, (2) Auditory, (3) Olfactorius, (4) Palatinus, (5) Trigeminus, (6) and (7) Vagus and Accessorius. It is curious that he repeated the error which Galen had exposed of tracing the origin of the nerves to the meninges.

FERNEL's teaching on the Nervous System was practically that of Galen, except that he gave a more minute account of the Trigeminus.

JACOBUS SYLVIUS (1478–1555) is still commemorated by the fissure in the brain which he described. He was, perhaps, the last of the Galenic school of anatomists who paved the way for Andreas Vesalius.

ANDREAS VESALIUS was born at Brussels, December 1st, 1514, and died October 2nd, 1564.

Putting aside that arrant mountebank Paracelsus, Vesalius was the first to dispute the authority of Galen, paramount for many hundred years, especially with regard to anatomy. Hitherto, anatomists, including the celebrated Sylvius, whose pupil Vesalius was, saw anatomy only with Galen's eyes; Vesalius insisted on using his own. Galen, he maintained, never dissected a human body in his life, but learned the little that he knew from examination of apes and other animals.

He scoffed at Galen's description of the "Rete mirabile," or wonderful net-like plexus in the brain, corrected his statement as to the number of bones in the sternum, sacrum and coccyx, the use of the intercostal muscles and the existence of the panniculus. Yet in his account of the nervous system he differed from Galen only in minor points. The difficulty in obtaining human subjects for dissection was almost as great for Vesalius as it had been in Galen's day.

In his youth, Vesalius risked his life by robbing gallows-trees and graves. Becoming more cautious, he succeeded in persuading judges to have criminals executed in such a manner as would not spoil them for the purpose of dissection and to hand them over to him for public demonstration in anatomy.

The Alleged Vivisection of Men in the Sixteenth Century

This charge was made against Berengario of Carpi, Vesalius, and Falloppio in particular, but against the anatomists of the University of Pisa in general.

After fully discussing the question of its truth, Dr. Withington (*Medical History from the Earliest Times*, App. vii.) says that condemned criminals sent to Pisa were usually executed there by the legal officers, probably by drowning or suffocation and then anatomized, and there is strong but not undoubted evidence that they were sometimes poisoned by the anatomists themselves, but there is not the slightest indication that any of them were vivisected, and the strongest possible evidence to the contrary.

For further refutation of the calumny reference may be made to *Hæser*, II, 25; *Roth*, *Andreas Vesalius, Bruxellensis*, Berlin, 1892, p. 473.

In 1538 he published under the sanction of the Senate of Venice some Anatomical Tables, and four years later, when not 28 years of age, he produced his great book in seven volumes entitled *The Structure of the Human Body*.

In both these works he had the advantage of the services of Stephanus von Calcar, a pupil of Titian's, as an illustrator, whose woodcuts must have been of the utmost value to the many whose opportunities for dissection were few and far between.

NOTE ON THOMAS GEMINI

We have in our Library a translation of Vesalius' anatomy with copper-plate etchings of the original wood-cuts by Von Calcar.

The book is by "GEMINI." Dr. J. F. Payne tells me that this person was a Fleming, his name being probably an assumed one indicating that he was a twin. Although he was surgeon to the King, proceedings were taken against him by the College as an unqualified practitioner, which, in fact, he was.

The publication of this book gave great offence to Vesalius, who accused Caius of having annexed his work.

The first edition of Gemini's work was published under the title *Compendiosa totius Anatomiæ delineatio ære exarata*, London, 1545, in folio. English editions also appeared in 1553 and 1559.

Some of the anatomical plates are in superimposed layers, and Dr. Payne thinks that Vesalius himself intended his plate to be used in this manner.

Steffan Michelspacher in 1615 also published anatomical plates designed to be lifted off in layers. *Catoptri Microcosmici visio prima, secunda, tertia*, etc. (*Pinax Microcosmographicus*).

These plates were inspired by, even if they are not direct copies of, Remmelin's *Catoptrum Microcosmicum*, which, according to Sir D'Arcy Power (*Med. Chir. Soc. Transactions*, Vol. XC, 1907, p. 451), was published without his consent in 1613.

Sir D'Arcy Power exhibited before the above Society four "dissected plates," mounted on cardboard, representing the male and female body from youth to age allegorically. The plates are entitled Spring, Summer, Autumn and Winter. He regards them as earlier than either of the two mentioned above (*Transactions*, XC, *loc. cit.*).

The high place of Vesalius in the history of Medicine is due solely to his reiteration of Galen's claim for the study of anatomy as the basis of Medical Science.

He made no memorable contributions to physiology or pathology, no noteworthy clinical observations of disease, nor, to his credit, be it said, did he invent any methods of treatment associated with his name.

With hinted doubts and covert sneers, he yet adhered to Galen's physiology. Whether his views were more advanced than Galen's we shall never know, for in a rage at the opposition of orthodox Galenists to his teaching, he burnt his manuscripts, became a humdrum Court physician to Charles V, and ended his scientific career before he was thirty in the year 1544.

In 1561 his old enthusiasm was aroused by reading the anatomical observations of Falloppio, on which he wrote a criticism based on memory of his past researches, for he had no recent investigations to record. But this was his final effort. In 1563 he made a pilgrimage to Jerusalem. A well-known legend is that he did so as an act of expiation for opening the body of a woman, or some say a man, still alive, but in a trance. More probably, according to Clusius the botanist, the pilgrimage was self-imposed in consequence of ill-health and mental boredom. On his way back in 1564 he died.

Vesalius, in abusing Galen, was following in Galen's footsteps. Galen renounced most recognized authorities and relied on personal observation; Vesalius did the same, and reviled the greater man who led the way.

Both met with strongest opposition during life, and both were canonized as pioneers of Medicine after death.

Like Galen, Vesalius placed the *vital spirit* in the substance of the heart, the *natural spirit* in the liver, the *animal spirit* in the brain.

He believed that the liver prepares the cruder blood together with the *natural spirit*, and the heart supplies the purer blood together with the *vital spirits* which are distributed to the organs throughout the body.

The *animal spirit* is manufactured in the brain, which uses it for the operation of the *chief soul*, and is continually distributing it to the instruments of the senses and of movement by means of nerves as it were by cords.

Nerves serve the same purpose to the brain that the great artery does to the heart, and the Vena cava to the liver, inasmuch as the nerves convey to the instruments to which it ought to be sent the animal spirit prepared by the brain, and hence may be regarded as the busy attendants and messengers of the brain. This is simply an echo of Galen.

The material for the *animal spirit* is derived from the *vital spirit* in the arteries, especially the arteries which are in the neighbourhood of the pituitary gland (which secretes the mucus of the brain) and also from the air which enters the brain through the cribriform plate and other orifices in the skull which look towards the palate.

NOTE ON HYPOPHYSIS CEREBRI

The pituitary body was regarded as of great importance as the secretory organ of Mucus in the brain. As such, it was the cause of all catarrhal disorders. It was not until Conrad Schneider (1614–80) demonstrated the use of the Mucous Membrane of the nose (Schneiderian membrane) that an immense amount of false pathology was overthrown.

It is only recently that the discovery of the association of disease of the Hypophysis with Acromegaly and Gigantism has raised the status of this organ to something of its former importance.

Vital spirits brought by the arteries and air in respiration are elaborated into animal spirits in the lateral and third ventricles by the special power of the brain. Thence through the iter, a portion of animal spirit passes to the fourth ventricle and downwards into the dorsal medulla and into the nerves springing from it.

From the other ventricles of the brain above the fourth, the spirit is carried into nerves springing directly from them, and so to the organs of sense and movement.

Galen, as we have seen, came to no decision on the point, and Vesalius refused to discuss whether the "animal spirit is carried along certain hollow channels of the nerves as the vital spirit is carried by the arteries, or whether it passes through the solid material of the nerves, as light passes through air."

But in any case it is through the nerves, he says, that the influence of the brain is brought to bear on any part.

This he proved by vivisection, showing, as Galen had done, that the action of muscles is prevented by dividing or ligaturing their nerves, and also that if the spinal cord be cut across, all the parts supplied with nerves leaving the medulla below the section will be deprived of sensation and movement.

Vesalius was no psychologist. He would draw no conclusions as to the operation of the chief soul, as to the mode by which imagination, thought, and reasoning are effected by the brain. He scoffed at those who assigned these processes to different cerebral ventricles.

The brain to him was the site of the chief soul, and also manufactured it. It distributed the animal spirit through the nerves and thus motion and sensation are effected. He learnt by vivisection that when the brain is removed, sensation and movement are annulled. Further than this he would not go. He held that all speculations on the nature of the soul itself were rash and premature. Moreover, they might have brought him into conflict with the Church. So he refused to draw any conclusions which could not be verified by anatomical and experimental investigation.

Amongst the structures in the brain which he described may be mentioned the Septum lucidum and Fornix. He also maintained that the functions of nerves as conductors were not dependent on their sheaths, but on their substance.

Of other sixteenth-century anatomists who contributed to our knowledge of the nervous system may be mentioned :—

Berengario, of Carpi (1502-50), who described the pineal gland, connection of the ventricles with the central canal of the cord, and showed that no nerves spring from the cerebellum.

Massa (1499–1569), first recognized the Olfactory as the first pair of nerves. Galen, as already mentioned, regarded the Olfactory bulbs as processes of the brain, and not as nerves.

Falloppio (1523–62), discovered the chorda tympani.

Koyter, his pupil (1534–1600), first described the anterior and posterior spinal nerve roots, and also made observations on the changes found in the brain and cord after delirium, convulsions, and paralysis.

To Varolio (1543–75) we are indebted for description of the Pons varolii, optic commissure, and Crura cerebri. Galen, as we have seen, denied that the optic nerves crossed in the chiasma.

Aranzio (1530–89), gave its name to the Pes Hippocampi.

Eustachius, who died in 1574, traced the optic nerves to their origin, and discovered the sixth nerve, unrecognized by Galen.

Pathological Anatomy

Pathological anatomy at least made a beginning in the sixteenth century, but speedily came to an end, for the opportunity of confirming and reversing diagnosis was by no means welcomed by the majority of medical men. So much rivalry and malice was the result of

Sectio cadaveris that in 1598 the practice was officially prohibited in Italy.

Another explanation of the prohibition is that certain enthusiastic pathologists were mobbed for removing the uterine appendages from corpses, and thus depriving their owners of all chances of fecundity in Paradise.

Seventeenth Century

The seventeenth century is chiefly remarkable for the rise of the so-called Iatro-mechanical, -physical, or -mathematical school, and its theories on the workings of the nervous system.

The study of natural philosophy and mechanics necessarily led to the conception of the human body as a mere machine composed of levers and pulleys and similar apparatus put into activity through the nerves by means of the soul or spirit residing in the brain.

Those who regarded the animal spirits as fluids naturally assumed that such fluids should obey natural laws and require channels in which to flow; therefore the nerves must be hollow. Those who regarded the spirits as aerial or vaporous accepted the view that the nerves were solid, and that nervous activity was the result of varying degrees of tension or vibration of the nerves produced by spiritual agency.

Isaac Newton was the first to suggest that nervous action is the result of vibration, that the sense of sight is caused by rays of light setting up vibration of the solid optic nerves and thence propagated to the brain (cf. THOMAS YOUNG, p. 7).

DESCARTES (1590–1650), was perhaps the most interesting exponent of the doctrine that man is a mere machine.

He knew nothing of anatomy or of physiology, beyond a smattering which he had picked up concerning the structure and function of nerves.

He had seen and admired the ingenious figures which adorned rich people's gardens in his day ; statues which spouted water or shot it out of guns at unwary passers-by ; Neptunes who made tottering charges with their tridents in defence of jerky marionettes in the shape of nymphs ; shepherds who produced sounds remotely suggesting words or a tune. Things which were regarded as mechanical triumphs then, but which would only excite derision now, inspired Descartes with the notion that human beings are but automata.

He compared the man who lived in a hut in the gardens and turned the water on and pulled the wires which worked the machines, to the " rational soul " which resided in the pineal gland.

There was no particular reason for placing the soul in the pineal gland [which we now know to be only the vestigial representation of a central eye] except that it happened to be a single or unpaired organ.

Descartes thought that the motive power which guided the machine-man was heat innate in the heart, fed and sustained by food carried to it.

Blood heated and rarefied in the heart engendered " animal spirits," which by physical and mechanical laws carried out all movements of the body in response to changes in the environment. Animal spirits also by working on the " rational soul " gave rise to modifications of thought.

The nature of the animal spirits was that of " air, wind or flame, a very subtle fluid " which was carried by the arteries to the pineal gland, which acted as a reservoir for them, whence they flowed to the ventricles, a secondary reservoir, and thence through the nerves, which he alleged to be tubular and also provided with valves, to aid them to carry out all movements of the body.

" As the spirits enter thus into the ventricles of the brain, so they pass thence into the pores of its substance, and from these pores into the nerves. And according as they enter or even tend to enter into this or that nerve they have the power of changing the form of the muscle into which the nerve is inserted and by this means of making the limbs move."

Descartes certainly drew a distinction between afferent and efferent impulses. For he held that the nerves were not merely hollow tubes but contained innumerable little threads which passed to the pores in the brain.

If the skin were stimulated, e.g. by fire, these delicate threads acted like bell-pulls to open the appropriate pore in the ventricles and so let out spirits into the nerves and gave rise to desired muscular movement.

This also suggests the idea of reflex action.

He used the mobility of the pineal gland to explain certain psychical phenomena. By leaning now this way and now that, towards different pores, it directed the flow of spirits towards certain parts of the brain rather than to others, and so promoted concentration of thought and prevented confusion of ideas. "So," he explained, "you see how one idea prevents another being received." He seems here to anticipate the modern doctrine of dissociation.

The function of the pineal gland was to receive indelible impressions on its surface, and when the spirits in the ventricles were in doubt they looked to the pineal gland for guidance in action.

The rational soul itself only took cognizance of these forms or images impressed on the surface of the pineal gland and used them for the purpose of thought, imagination, memory and desires.

All else was the work of the bodily machine sometimes actuated by the soul, but sometimes only by the animal spirits.

The importance of Descartes' views on the nervous system is overshadowed by his purely fanciful and figurative expressions. He clearly separated what we call reflex phenomena from conscious action; he recognized afferent and efferent impulses.

As Sir Michael Foster says: "If we substitute in place of the subtle fluid of the animal spirits the molecular changes which we call a nervous impulse, if we replace his system of tubes with their valvular arrangements by the present system of concatenated neurons whose linked arrangement determines the passage and effects of the nervous impulses, Descartes' exposition will not appear so wholly different from the one which we give to-day (*History of Physiology*, p. 268).

At the same time, Galen's views on the nature of nervous action approach more nearly doctrines of modern times, and have far more scientific accuracy than those of Descartes.

Thomas Willis (1621–75), one of the most successful physicians of the seventeenth century, made his name chiefly by his classical study *De Anatome Cerebri*, in which he was largely helped by Lower, an honest, able seeker of truth, but too tactless and unworldly to secure riches.

Willis's additions to the knowledge of the anatomy of the brain, its ganglia, and circulation; his conception of afferent and efferent impulses and their paths, which, however, he held to be the same in the brain; his attempts to localize function in the cortex and ganglia; his correct description of the ventricles as lymph spaces and not as important reservoirs for the storage of animal spirits; his view of the cerebellum as the source of involuntary actions, would alone render his name famous among neurologists.

But he also clearly expressed the modern doctrine of reflex action. Speaking of lower animals which have no developed brains he says: "They being destitute of the internal principles of motion, move themselves all members only as they are excited from the impulse of the external object, and so sensation preceding motion is in some manner the cause of it."

And, again, he says: "We may admit that the impression of an object driving the animal spirits inwards, and modifying them in a certain peculiar manner, gives rise to *sensation*, and that the same animal spirits, in that they rebound from within outwards in a reflected wave as it were, call forth *local movements*."

Willis, like Descartes, admitted that "man possesses a rational soul, immortal and incorporeal, but putting aside everything which is due to the direct activity of this rational soul, the nervous as well as the other phenomena both of men and of animals may be regarded as the phenomena of a corporeal machine" (Foster, p. 271).

Apart from the rational soul which was the governor of all, man possessed a corporeal soul consisting of two portions—"flame" and "light." The flame was literally a fire which burnt in the blood, invisible like fireflies or phosphorescence by daylight, yet ever burning and giving forth heat to all the body.

He rejected the old idea that heat was innate in the heart, saying, "The heart gets its heat from the blood, *not* the blood from the heart."

From the products of combustion occurring in the blood, lighter and more spirituous aerial and volatile particles ascended by the carotids to the brain, in the cortex of which they were distilled, as it were, into the animal spirits, and thence diffused over the whole nervous system.

The animal spirits thus formed were the second half of the corporeal soul, and were of the nature of rays of light.

The animal spirits prepared in the cerebrum were destined for voluntary movement and sensation; those in the cerebellum for involuntary movements, for the beat of the heart, respiration and the like.

Willis in his quaint and fantastic description of the animal spirits betrays considerable confusion of ideas.

He applies to them the term " light " sometimes to convey the idea of shining rays and sometimes to express the fact that they were without weight.

I have already mentioned that the term fluid applied to the animal spirits led to the conviction that the nerves must be hollow in order to contain them.

With a similar confusion of thought Willis speaks of animal spirits sometimes in the original sense as volatile vapours, aerial, intangible, or like electricity, and sometimes as though they were possessed of personality, like mischievous imps and pixies ; sometimes as a " nervous juyce which being derived from the brain and cerebel into the medulla and appendix is carried from thence by a gentle sliding down through the nerves." The latter, though not actually hollow, " are furnished throughout with as it were so many little holes in a honeycomb " or in a porous cane.

As long as " the animal spirits are pure and are carried in the open spaces of the brain and its appendages they behave tranquilly enough, but when shut up within muscles and there permeated with sulphurous (combustible) particles from the blood, and sometimes with heterogeneous matter in other places, they become exceedingly impetuous, that is elastic, or spasmodic."

Sometimes the animal spirits behaved like a riotous gang of bandits, possessing secret caves and hiding-places whither when turbulent they had to be driven by evil-smelling drugs, or whence they were to be coaxed when sulky by sweet scents and essences.

In this way he explained the phenomena of convulsions and paralysis and their treatment.

But in general, for conveyance of sensation and motion, the spirits were orderly enough. They were arranged in serried ranks all along the nerves in military fashion. On receiving a peripheral sensation they handed it on to the brain and dutifully obeyed the command for motor action which they received.

In another place he explains nervous action on the Iatro-mechanical principles.

The animal spirits present in the nerves induce " in each a certain tenseness." The nerves are like cords lightly strung between the brain and the periphery, and owing to this continuity, if either extremity be struck, the blow is forthwith felt throughout the whole— " When the impression passes outwards from the brain along the nerves to motor structures, movement is produced. If, on the other hand, the impression started from without is carried inwards to the brain, sensation is the result."

We could not find a clearer account of afferent and efferent impulses than this.

However, elsewhere, in explaining muscular action he was entirely misled by the opinion generally held that muscles in action gained in bulk.

The animal spirits lurking in the tendons of muscles " leap into the fleshy fibres and presently afterwards, their impulses being exhausted, falling back, they retreat into the tendons ; and this is repeated again and again." Here we see Willis's conception of the spirits as personalities.

Then he makes use of *Iatro-chemical* views of the matter, for he goes on to say :

" When, however, the animal spirits at the bidding of the instinct to bring about movement, rush from the tendinous to the fleshy fibres, then they meet with active particles of a different nature supplied by the blood, and forthwith the two mixing *effervesce*, so that out of the struggle and agitation of the two, the fleshy fibres, previously lax and porous, are stuffed full and thrown into corrugations, and all the fibres being thus corrugated at the same time, the contraction of the whole muscle is brought about."

The notion that muscles in contraction gained in bulk was prevalent. Willis thought that the animal spirits leaped from the tendons into the muscles, effervesced and made them swell up. Mayow attributed a similar effervescence and swelling up of muscle to fermentation set up by union of his " nitro-aerial spirit " with combustible sulphurous particles residing in the muscles.

Borelli[1] (1618–79), substituted for animal spirits a " Succus nerveus " which permeated the sponge-like nerves, and these, when concussed by command of will in the brain, " can squeeze out and discharge from their extreme orifices some spirituous droplets into the appropriate muscle, whence the ebullition and explosion follow by which the muscle is contracted and rendered tense."

Borelli disposed of the whole theory of effervescence taking place during muscular action by showing that when the muscles of animals struggling under water were cut no bubbles escaped. It is curious that he did not see that the same experiment disproved his own contention that muscular contraction depended on " ebullition and explosion." But the entire conception of muscular contraction was shattered at one blow by Glisson (1597–1677), who proved by means of a plethysmograph which he invented that a muscle during contraction does not swell up or gain in bulk but loses it.

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[1] Borelli appreciated afferent impulses. Concussion of the periphery of the nerves, he said, was conveyed mechanically through the spongy nerves permeated with Succus nerveus to the brain.

In his work *On the Motion of Animals* Borelli described the mechanical principle of locomotion and calculated the force mathematically and with singular inaccuracy. Thus he estimated the force of each heart-beat as overcoming a resistance of 180,000 lbs.

Pitcairne (1652–1713) made out that the combined work of the stomach diaphragm and abdominal muscles equalled a force of 461,219 lbs. It is not therefore surprising that he attributed digestion in the stomach to the mechanical attrition of food.

Such were some of the absurdities with which the Iatro-mechanical physicians were led.

Stenson's (1638–86) contribution to the knowledge of the nature of muscular contraction was no less important, for he showed that when a long muscle is cut up lengthways into pieces, each piece may be made to contract, and therefore that the power of contraction resides in the fibres of muscles and not in the whole muscle as a machine (Foster). He also had the merit of attributing muscular action to the fleshy and not to the fibrous parts of muscles as Galen and all his successors had taught.

Before leaving Willis, allusion must be made to his notions as to psychology and the functions of animal spirits in this relation.

The middle regions of the brain were " fitted with dioptric mirrors as with windows." Pictures or images of all sensible things were admitted by means of the ducts of the nerves through the Corpora striata into these secret places, and were then represented on the Corpus callosum, " as on a whitened wall." And so things which gave rise to sensation induced perception and a certain imagination. Thence the images or pictures were passed on and stored in the cortex of the brain as memories of things, though the mere images of them had vanished from the Corpus callosum.

Subsequently when the animal spirits became excited by some particular impression, " they looked back upon the object by whose impulse they were set in motion, and so for the sake of laying hold of it, or driving it away," they gave instructions to other spirits flowing along the nerves to carry out appropriate movements.

" Thus, sense gives rise to imagination, then to memory or to impulse or both of them, and impulse finally gives rise to local movements which bring about the performance or the avoidance of the apparent good and evil."

Willis regarded the Corpora striata as the " Sensorium commune." All sensations passed through them and the Corpus callosum to the cortex. Similarly all motor impulses passed by the same path to the periphery. We cannot deny the correctness of his views to a certain extent concerning the afferent and efferent paths in the brain, although the " sensory crossway " was not known by him.

Willis's views in general were severely criticized in his day by MAYOW and STENSON, who, by the way, knew that the third nerve contracted the pupil.

MAYOW denied the existence of " a vital flame by whose deflagration the whole mass of the blood is heated, the heart living like a salamander untouched in the midst of the flame." Nor would he accept the view that such heat was " strong enough to give rise to light the rays of which transmitted to the brain are to be thought to form the sensitive soul."

Yet Willis conveyed very clearly the idea of oxidation, suggested by Mayow himself in his theory of a nitro-aerial or igneo-aerial principle as the cause of animal heat, which principle a hundred years later was called Oxygen by Lavoisier.

STENSON refused to accept any dogmatism as to the nature of nervous action and localization of function in the brain, which he regarded as so complex and difficult to dissect that no physiological deductions whatever could accrue from its examination.

At the same time he spoke of the white substance as wholly fibrous in nature, and said : " We must necessarily admit that the arrangement of its pores is made according to some definite pattern on which doubtless depends the diversity of sensations and movements."

Sir Michael Foster, I think, hardly does justice to Willis. Beneath all his grandiose verbosity there is always a substratum of sense. It may be doubted if he really believed in the personal attributes which he ascribed to his animal spirits. More probably he was trying to convey knowledge to the people in the manner adopted by authors of "Popular Science Manuals" of the present day.

In the seventeenth century it was fashionable to dabble in medicine, and medical books were usually dedicated to some nobleman who doubtless assisted in circulating them provided they were not so dull and difficult to understand as to send him to sleep.

Willis's language is unscientific, but it is certainly not dull, and so would appeal to the lay public from Charles II—himself an amateur scientist—downwards.

MALPIGHI (1628–94), devoted much attention to the histology of the nervous system. He showed that the white matter consists of fibres arranged in bundles whose course is difficult to follow, but which in any case form tracts connecting the surface of the brain with various regions of the spinal cord. He also described the grey matter in the cortex, the ganglia, and spinal cord.

Emboldened, however, by his discoveries on the nature of glands he adopted the ancient doctrine that the brain itself was a gland for the secretion of vital and nervous spirits, as originally it was held to be for the secretion of mucus.

GLISSON (1597–1677), besides proving that muscles during contraction did not swell up and gain in bulk but lost it, deserves special mention as the discoverer of the quality of *Irritability* in living structures, which was elaborated in the next century by Haller, and was an important addition to neuro-physiological science.

Of other anatomists who added to our knowledge of neurology in the seventeenth century—

VIEUSSENS (1641–1716), perhaps gave the best and most complete account of the central and in part also of the peripheral nervous system. He is said to have performed five hundred dissections.

LANCISI (1655–1720), drew special attention to the distinction between the grey and white matter of the brain. He followed Descartes in placing the seat of the soul in the pineal gland and Corpus callosum on the ground that these are unpaired organs of the brain.

Valsalva (1666–1723), gave a minute account of the internal ear, and its innervation.

Borri, of Milan, in 1669, analysed the brain and estimated its proportion of fat as 25 per cent.

Leeuwenhoek, Ruysch and Malpighi introduced Histology. The compound Microscope was invented, some say by Lippersheim in Middelberg, 1608, others by Jansen in 1620 ; and it was fitted with better objectives by Robert Hooke (1635–1702).

The great advance in the study of anatomy in the seventeenth century led to an enormous increase in knowledge of the nervous system, but there were also counteracting influences.

Sydenham (1624–89), despised anatomy and physiology, and except for his masterly account of chorea, he made no contributions to neurology.

It is to be regretted that William Harvey did not use methods in the investigation of the nervous system which were so strikingly successful in his elucidation of the circulation of the blood.

The influence of Stahl and Stenson was even hostile to the progress of neurology.

Stahl (1660–1734), opposed Descartes and others who upheld the mechanical and chemical schools, denying that the phenomena in living beings resembled in any way the chemical and physical events observed in non-living bodies.

As the founder of " Animism," he held that all phenomena in the living body, physical and chemical, are dependent on the action of an universal " sensitive soul," which is diffused over every part of the body, from the brain to the little finger.

Such views, implying disparagement of the study of nervous anatomy and physiology, together with Stenson's pessimistic teaching that the brain was far too complicated to understand, did much to discourage the pursuit of scientific neurology.

Vitalism or Animism more or less in accordance with Stahl's views was taught by Unzer (1727–99), who held that nervous influence which he identified with "Irritability," "Sensibility," and "Vital force," is brought about by the working of an all-pervading "Soul."

The teaching of VAN HELMONT (1578–1644), who placed the seat of the soul in the pylorus, was anything but progressive as compared even with that of Vesalius. His invention of a principle which he called "Blas motivum," to take the place of animal spirits as the cause of nervous energy, was a purely verbal distinction.

Endless wrangles as to whether the soul resided in the ventricles, the corpus callosum, or corpora striata, the pineal gland, septum lucidum, or pons and medulla, were futile except that they gave an impetus to the discovery of cerebral localization of nervous function in general.

The advancement of knowledge of chemistry and physics led to many erroneous doctrines concerning the nervous system, and its workings. But at the same time the conception that certain neuro-muscular phenomena, namely, reflex action and irritability of living structures are distinct from higher mental activities, led the way to future science.

The Iatro-physical or Mechanical school survived for at least a hundred years.

Its chief exponents in the eighteenth century were Hoffman, Bryan, and Nicholas Robinson.

FRIEDRICH HOFFMAN (1660–1742), introduced, in opposition to Stahl, a dynamic and material force which he called "Æther," to explain nervous energy. Disease and health were dependent upon varying degrees of "Tonus," disease being either in the direction of Spasm or Atony.

Bryan (1732), and Robinson (1725), following Newton, assumed the existence of an animal *Æther* in place of the nervous fluids or animal spirits, and Robinson referred sensation to vibrations of tense nerve fibres, and nervous diseases to excessive tension of these fibres.

William Cole, of Bristol (1675), had already attributed fever to *Tension* of nerves occasioned by deposit of abnormal material on their roots.

Somewhat similar views were entertained by William Cullen (1712–90). He invented a system which he called " Nervous Pathology." The proper life-giving element was " Nervous Force," " principle," or activity or " animal force," or " energy " of the brain and spinal cord.

It differed from the material " Æther " of Hoffman, and the " Anima " of Stahl. It was the soul itself immaterial and reasoning, and it acted through the nerves. Thought begot movement, and was also begotten thereby.

This Nervous principle produced Spasm and Atony. All diseases were associated with one or the other, and were to be treated accordingly by antispasmodics or stimulants.

It is fortunate that as a rule even the chief of the Iatro-physicists saw the absurdity of applying strict rules of mathematics to the explanation and treatment of disease.

Even Baglini, a staunch Iatro-physicist, was wise enough to be illogical and to separate his theories from his practice.

Had this not been the case we may be sure that more patients would have been slain than actually perished under the régime of this school, and the same may be said of every dogmatic and methodistic system of medicine which has prevailed.

Eighteenth Century

The eighteenth century is usually regarded as blank with regard to neurological progress, but it produced at least one great neurologist, whose views were lasting. This was ALBERT VON HALLER (1708–77), of Berne, who took up, elaborated, and refined Glisson's principle of *Irritability.* Glisson had applied the term to all living structures in general, but Haller demonstrated this irritability as a peculiarity of the *muscles* as opposed to sensation as the second vital phenomenon.

Muscular motion, he taught, was dependent on three forces : " Dead nervous force " (elasticity), " Innate nervous force " (irritability, " *vis insita* ") and " Nervous force in itself " (" *vis nervosa.*")

As the result of 567 experiments to decide which parts of the body possess irritability, he concluded that it was a property of muscles alone, entirely independent of their nerves ; a doctrine confirmed many years later by observations on the action of curare.

Haller, moreover, proved that sensation takes place in nerves or occurs only in organs endowed with nerves. All parts in which are found both nerves and muscular fibres are at once sensible and irritable, but the property of irritability is not identical with sensibility. He distinguished elasticity or " dead force " from irritability, " *Vis insita,*" and again from the " nervous force," " *Vis nervosa,*" and from the power of the Soul itself.

The " *Vis nervosa* " is the force which is carried from the brain to the muscles by the nerves, the power by which muscles are called into action.

This, like the " *Vis insita,*" survives the death of the body, for muscles after death may be caused to contract either by irritating their fibres directly or the nerves which supply them.

As to the nature of nervous action he repudiated the mechanical view that it is occasioned by oscillations and varying degrees of nerve tension.

As regards the nature of the "*Vis nervosa*," after discussing the ancient idea of the spirits he decided that it is a fluid, but not like an albuminous solution, nor spirituous like alcohol, nor acid, nor sulphureous (combustible), nor like ether nor electricity, but "an element of its own kind unlike everything else." No discovery, it is true, yet an advance on theories which led to dangerous therapeutical doctrines.

And then he fell into the old error. The "*Vis nervosa*" being a fluid, the nerves must be hollow in order to convey it, and therefore he argued by analogy, the fibres of the brain must be hollow, too.

The "*Vis nervosa*" was the same for both movement and sensation, and for the preservation of life, and was not composed of two kinds, one connected with the cerebrum, and the other with the cerebellum. The same fluid served for both movement and sensation, and was contained in the same nerves. It was supplied and nourished by the arteries of the brain. In his chapter on the "Phenomena of the Living Brain," he argued that the brain, its component parts, and also the nerves, being all alike in nature, are also alike in function.

As the nerves are the only parts which feel, and as they are all gathered together into the medulla, he decided that the central part of the brain feels, and in it are presented to the mind the impressions which the nerves, disturbed at their extreme ends, have carried to the brain.

Sensation manifests itself in movement, and when the corpora striata, the thalamus, crura cerebri, pons and medulla are irritated, movements are the result.

He went on to argue that the cortex of the brain being like other parts must also feel, "although no movements," he said, "result when it is irritated."

Evidently in his experiments he had not hit upon the motor cortex. Had he done so he might have anticipated Hughlings Jackson's doctrine of representation and re-representation of movements in the lower and higher areas of the brain—and perhaps also the discoveries of Hitzig, Ferrier, Horsley, and others.

He rejected the teaching of Willis that the corpora striata are the seat of sensation and the source of movement as well as the view that the cerebellum is essential to life.

As to the seat of the soul, he refused to accept the Stahlian opinion that the soul and sensorium commune are diffused all over the body from brain to finger-tips.

At the same time he would not place it in the cortex, the corpus callosum, or the septum lucidum, or in the tiny pineal gland or the corpora striata or in any particular region of the brain.

But as both sensation and motion have their source in the medulla, and this also is the conjoint origin of all the nerves, the medulla must therefore be the seat of the soul. Substitute "seat of Life" for "seat of Soul" and Haller's view is that of Galen, and that of the present day.

He declined to express an opinion on the question whether different parts of the brain correspond to different functions of the soul.

"Our present knowledge," he said, "does not permit us to speak with any show of truth about the more complicated functions of the mind or to assign in the brain, to imagination its seat, to common sensation its seat, to memory its seat." Were Haller with us now, he would not alter his opinions.

Haller died in 1777. Although he was the greatest of early eighteenth-century neuro-physiologists, others may be mentioned. Robert Whytt (1714–66), discussed acute internal hydrocephalus, and also, in conjunction with Stephen Hales (1677–1761), dwelt on the reflex action of the spinal cord, which, as we have seen, was presumed by Descartes and described in a tentative way by Willis. Whytt also wrote in 1764 an interesting treatise on nervous disease entitled *Observations on the Nature, Cause and Cure of those Diseases which are called Nervous, Hypochondriac, or Hysteric.* Prochaska in 1784 also made important contributions to this subject.

François du Petit (1664–1741), was the first to divide the cervical sympathetic for experimental purposes. He also declared that nerve fibres decussate freely in the brain and spinal cord.

Morgagni (1682–1772), the great pathologist, was the first to speak of Meningitis—the term Phrenitis having been applied to all or most cerebral affections hitherto.

Hoffman and Büchner (1701–69), demonstrated cerebral hæmorrhage as a cause of apoplexy, though it was already known to be so in the preceding century. It will be remembered that Malpighi died of cerebral hæmorrhage in 1694 and Baglivi discovered two pounds of blood in his right ventricle. J. J. Wepfer, 1678, published *Observations on the Relation between Apoplexy and Cerebral Hæmorrhage.*

Chr. Gottlieb Ludwig (1709–73), introduced the study of diseases of the spinal cord. Richard Powell, (1766–1834), discussed diseases of the brain and nerves. The histology of the nervous system which had been studied with so much promise in the seventeenth century by Leeuwenhoeck, Ruysch and Malpighi, was neglected in the eighteenth century, perhaps owing to the followers of Stahl, who held it useless, and of Stenson, who thought nervous structures were far too intricate to unravel, although he recognized the fibrous nature of the white substance as Malpighi had done. It must be admitted, however, that the early microscopes were very misleading instruments.

The pathology of nervous affections showed very little advance until the end of the eighteenth century.

The term Apoplexy was still used in its earliest sense as unconsciousness with loss of sensation and motion. It was subdivided into carus, lethargy, coma, and covered practically all conditions of unconsciousness and semi-consciousness from any cause. Hence endless disputes arose as to treatment by bleeding, counter-irritation, and so forth.

Occlusion of blood-vessels, by embolus or thrombosis, and, indeed, arterio sclerosis and all diseases of the blood vessels, except aneurysms, were unknown, in spite of innumerable treatises on the pulse.

Serous apoplexy, as opposed to sanguineous, was thought to be caused by effusion of serum inside or outside the brain, and the term serous apoplexy survived late into the nineteenth century.

Paralysis was divided into paraplegia, hemiplegia, paresis, and paralysis partialis, in which less than one-half the body, or some special part, organ, or nerve, was affected.

Little was known as to the etiology of paralysis beyond that which was stated by Galen, and excepting the results of pressure on the cord, which Galen described, its diseases were awaiting discovery.

Tabes dorsalis from the time of Hippocrates signified a wasting of the back due to sexual excess.

The term probably covered a number of the myopathies, and disease associated with wasting of muscles as well as every form of paraplegia.

Towards the end of the eighteenth century and the beginning of the nineteenth, however, a rapid revival of interest in the nervous system arose and has been steadfastly maintained ever since.

The principal anatomists and physiologists who followed Haller as neurologists were Reil, Behrends, Scarpa, Prochaska, De la Torre, Fontana, Monro,

J. Hunter, and Everard Home, who dealt chiefly with the innate and ultimate structure of the cerebrospinal system.

Whytt, Brodie, Richerand, Dumas, Bichat, Le Gallois, and above all Charles Bell and Majendie, revived experimental physiology.

Structure of Cerebro-Spinal System

Chemical analyses of the brain by Dumas showed the presence of phosphates of lime, ammonia, and soda (Dumas, *Principes de Physiologie*, p. 204). The discovery of the presence of fat in the brain by Borri, of Milan, has already been mentioned.

No important observations on the cortex were recorded, but the fibrillar nature of the white matter, recognized first by Malpighi, was confirmed.

Prochaska, Monro, Fontana, Reil, and Home described the nerves and white substance of the brain as consisting of transparent cylinders ensheathed in a pellicle, and containing gelatinous consistent humour. They contradicted De la Torre, who insisted that the brain, cord, and medullary portion of nerves were composed of a mass of innumerable transparent globules swimming in a diaphanous fluid.

E. Home examined the optic nerves of a horse and decided that they did not consist of tubes conveying a fluid, but of fibres of a peculiar kind (*Phil. Trans.*, Vol. LXXXIX, p. i).

Experimental Work

Eugéne Le Gallois (1804–31), set himself to distinguish the functions of the brain from those of the medulla and spinal cord, and decided that the phenomena of life, sensation and motion were less dependent on the brain and cerebellum than physiologists had hitherto supposed.

In his *Expériments sur le Principe de la Vie* (1812) he recorded a vast number of experiments which are extremely unpleasant to read.

His main conclusions were that the respiratory centre is situated in the medulla, that every part of the body derives its principle of vitality and irritability from that part of the spinal marrow from which it receives its nerves; that the heart is supplied not by a circumscribed portion but from the whole of the spinal marrow; that the sympathetic system originates in the spinal marrow, and that its function is to put each part to which it is distributed under the immediate influence of the whole nervous power.

The discovery of the respiratory centre is of sufficient importance, and led to that of the other vital centres in the part of the medulla which Flourens subsequently named the "Nœud vital."

MARSHALL HALL demonstrated that the action of the respiratory centres was both voluntary and involuntary in 1834 (*Proc. Zoological Soc.*, Aug. 12, 1834).

Some of Le Gallois' conclusions, however, were soon questioned by Wilson Philip and Brodie in this country.

WILSON PHILIP devoted much attention to the sympathetic system, and maintained that the powers of the heart, of the vessels of circulation and secretion, the peristaltic movements of the stomach and intestines, are all independent both of brain and spinal marrow, though all these organs are capable of being influenced through the nervous system.

Philip's main inferences from his experiments and observations were that "the power of muscles, both voluntary and involuntary, is independent of the nervous system, and arises from the mechanism of the muscular fibre itself." Both sets of muscles are equally capable of being excited by central nervous influence; but while this influence is the sole stimulus to which muscles of voluntary motion are subject, it acts only occasionally on muscles of involuntary movement. . . .

When the latter muscles are excited by nervous influence, it is not applied to them in the same way as to the muscles of voluntary motion to which it is sent directly from the brain and spinal marrow . . . each muscle receiving its nervous influence from a particular part of these organs ; while to the muscles of involuntary motion, it is sent through the great chain of sympathetic ganglia, each muscle receiving its nervous influence from every part of the brain and spinal marrow." (Cooke, Vol. I, p. 58).

Brodie contradicted Le Gallois' statement that " every part derives its principle of vitality and irritability from that portion of the spinal marrow from which it receives its nerves," by a crucial and cruel experiment. He divided all the structures about the shoulder of a dog with the exception of the axillary artery and vein, and showed twenty hours later that the arteries contained arterial blood and that the muscles reacted to electricity as strongly as if in response to the stimulus of the will.

According to Brodie it was the opinion of Haller and was generally held that the heart was excited to action by the stimulus of the blood which it contained. Brodie contradicted this by showing that hearts emptied of blood still continued to beat. He attributed the heart's contraction therefore to " certain impressions communicated through the nervous system."

It is strange that he overlooked the fact that hearts when removed from cold-blooded animals still beat, although they cannot then be influenced by impressions communicated through the general nervous system.

John Hunter (1728–93), according to Abernethy (*Abernethy's Enquiry into Hunter's Theory*) attributed irritability, nervous action, and all vital phenomena to the operation of some subtle, mobile, invisible substance, superadded to inert matter as magnetism is to iron, or as electricity is to the various substances with which it may be connected. This substance he called the *Materia vitæ diffusa.*

Abernethy was inclined to support Hunter on the ground that such a substance seems to pervade everything and to be the life of the world; and therefore that it was probable that a similar substance pervades organized bodies and produces similar effects on them (*Enquiry*, p. 33).

He distinguished between intellectual faculties dependent on the nervous system, and mere vitality which he maintained was independent of it. "In vegetables and in some of the lowest kind of animals," he said, "no traces of a nervous system are discoverable; and yet the irritability of life is manifest in all" (*Enquiry*, p. 68).

Sir W. Lawrence in his lectures before the Royal College of Surgeons ridiculed all attempts to penetrate the nature of the first cause of vital phenomena. The "Enormon," or "Impetum faciens" of Hippocrates, the "Archeus" of Van Helmont, the "Anima" of Stahl, the "Materia vitæ diffusa" of Hunter; the "Calidum innatum," the vital principle, the subtle and mobile matter of others, magnetism, electricity and galvanism, were, he said truly enough, merely different names to express the same idea.

He professed entire ignorance of the nature of vital properties except so far as they are disclosed by experience and observation, and said all such efforts to explain them "have been equally unsuccessful from the commencement of the world to the present time" (*Lawrence's Reply*, etc., p. 14).

Lawrence's attitude is that of modern neurologists. The divorce between metaphysics and neurology is now complete.

Psychology and neurology go no longer hand in hand.

The neurologist concerns himself chiefly with the minute structure of the nervous system, the localization of nervous function as indicated by physical signs and symptoms and verified by morbid anatomy.

Systems of purely psychical nature, and not referable to definite nervous lesions he ignores.

The whisper of the word "functional" is sufficient to deprive a case of nervous disorder of all interest to the neurologist.

On the other hand, the psychologist still strives for knowledge of the ultimate principle which underlies all nervous energy.

The "animal" spirits were dead, but have recently been revived under the brand-new designation, *Neuro Kymie*, an invention of the school represented by Foul, Karl Vogt, and in this country by W. McDougall (*Brain*, Part CXXII, Vol. XXXI, 1908).

Sir Charles Bell (1744–1842). With the advent of Sir Charles Bell at the beginning of the nineteenth century an entirely new epoch in neurology occurred.

Although the various parts of the brain and the columns of the cord were fully known to anatomists and physiologists, confusion reigned as to differentiation of their function.

All parts of the nervous system were thought to have common properties and functions. The brain and cord received sensations, produced movements, and the nerves conducted both.

All nerves were simple in structure and conferred both motion and sensation on the limbs.

The spinal cord, from which the nerves arise, being a prolongation of the brain, had the two functions of motion and sensation combined promiscuously in all its parts.

It was for Sir Charles Bell to take the first steps towards localization of function in the columns of the spinal cord.

In his essay, *Idea of a New Anatomy of the Brain*, printed privately for his friends in 1811, he said, " I found that injury done to the anterior portion of the spinal marrow convulsed the animal more certainly than injury done to the posterior portion."

Turning his attention to the posterior and anterior spinal roots which he knew to be connected with the corresponding columns of the cord, he said, " I found that I could cut across the posterior fasciculus of nerves which took origin from the posterior portion of the spinal marrow without convulsing the muscles of the back ; but that on touching the anterior fasciculus with the point of a knife, the muscles of the back were immediately convulsed."

Hence priority was claimed for him in the discovery of the function of the anterior and posterior spinal roots, and occasioned an acrimonious discussion, into which I need not enter.

The credit of the discovery, however, undoubtedly belongs to Majendie, who published his brilliant essays, *Expériences sur les Fonctions des Racines des Nerfs Rachidiens* and *Expériences sur les Fonctions des Racines des Nerfs qui naissent de la Moëlle Epinière* in 1822 ; and in 1823, *Note sur la Siège du mouvement et sentiment dans la Moëlle Epinière.*

Majendie courteously and generously agreed that Bell was very near to discovering the function of the spinal roots, but " did not actually show that the anterior roots are destined to motion while the posterior belong more especially to sensation."

On the other hand, Bell's masterly investigation of the cranial nerves, his demonstration of the function of the hypoglossal, fifth, and seventh nerves, place him in the foremost rank of experimental neurologists.

And yet it is excusable to mention once again that Bell's experiments were but repetitions of those performed by Galen eighteen hundred years ago.

The main localization of function in the spinal columns was thus established in the first quarter of the nineteenth century chiefly by Majendie. The subsequent developments and additions to our knowledge of neurology are not yet ancient history.

At the period at which I must leave the subject neurologists possessed a sound knowledge of the general anatomy of the nervous system.

The chief tracts of the spinal cord and their connection with the brain and cerebellum had been traced.

It is strange that the site of decussation of the motor tracts remained obscure, although the fact that decussation must occur was known to Aretaeus. Lancisi placed it in the Corpus callosum, Santorini in the C. pyramidale, Sammering and Haller immediately below the origin of the lingual nerves, and others in the pons.

The exact site was discovered by Gall and Spurzheim, and accurately described by them in the following words: "When we separate from each other the two inferior cords of the medulla oblongata and spinal marrow, we see that they are separated by a pretty deep fissure the bottom of which is occupied by transverse filaments. This fissure is only interrupted at one place which is only two or three lines in length. The fibres of the pyramidal eminence of one side form there three or four filaments, as the hairs of a mat, and which are blended afterwards with the rest of the medullary cord into which they thus enter obliquely" (Cooke, *Treatise on Nervous Diseases*, Vol. II, p. 114).

Gall and Spurzheim were both eminent anatomists, and the merit of their discovery should weigh against the discredit which they sustained as the inventors of the pseudo-science called phrenology.

The histology of the nervous system was as familiar as it could be in the absence of modern staining reagents.

The function of the cortex of the brain as the seat of intelligence and higher faculties, as the recipient of afferent sensory impulses and the originator of motor efferent impulses had been proved.

The cerebellar functions were unknown. Willis had, indeed, suggested that the cerebellum was the source of *involuntary* actions and also the seat of passions, but a view was prevalent and strongly supported by Alexander Walker in 1815 that the cerebellum was the seat of volition and the organ of voluntary movements.

By a curious mental perversity Walker reversed the order of things, regarding the anterior cerebro-spinal tracts as ascending and the posterior cerebello-spinal columns as descending (*General Theory of the Intellectual Faculties of Man and Animals*, Dr. Thomson's *Annals of Philosophy*, July, 1815, Vol. VI).

The site of the respiratory centre in the medulla had been ascertained by Le Gallois and Marshall Hall, who also elaborated the doctrine of irritability and reflex action.

Such nervous functions as co-ordination, muscular sense and tonus had not been scientifically described. Cutaneous reflexes, tendon jerks, ankle clonus were unknown. The electrical phenomena of living nerve and muscle, their normal reactions; the situation of motor points and the reactions of degeneration as yet were undiscovered.

The pathology of the many diseases which we now know to be associated with lesions of different areas of the cord, and many of these diseases themselves, are discoveries of our own times.

On the other hand, it may be said that by slow and painful steps the foundation and groundwork of modern neurology had been laid at last.

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